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WHAT WILL THE DEMOCRATS DO?

A FORECAST OF TARIFF LEGISLATION.

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FOR the first time since March 4, 1861, the three branches of the law-making power in the United States are now Democratic. After a generation of no or divided responsibility, the Democratic party can legislate as it pleases and execute in favorable spirit the laws it enacts. Moreover it is now in charge of the government of the United States at its own request, upon its representation that there is needed, not merely a radical reform in administration, but a radical change of public policy in most important respects, requiring sweeping legislation, which shall revolutionize our system of federal taxation by abolishing its most important present characteristics, and adopt a currency system of which honesty shall be the base and freedom from federal bedevilment the characteristic. Such is the promise it may be expected promptly to perform.

These subjects, it appears to me, properly find place in the scope of "a review of industrial progress," such as THE ENGINEERING MAGAZINE. Its reading constituency embraces the heads of many important manufacturing enterprises,—men who in the varied relations of life are potent factors in forming public sentiment and in making the real progress of the country. A large number of these men are, or have been, protectionists, and they naturally feel an interest, if not an anxiety, with regard to the trend of forthcoming legislation. Those among them who are advocates of tariff reform, at the same time, are looking with interest for the fulfillment

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of the pledges under which the new administration at Washington has been placed in power.

I.

As to the tariff, the principle by which legislation will be guided is the one inserted in its platform by an overwhelming vote of the body of the Chicago convention, viz. : that "*the Federal Government has no constitutional power to impose and collect tariff duties, except for the purpose of revenue only*" ; and the special details of tariff legislation promised are "*free raw materials, and cheaper manufactured goods that enter into general consumption.*"

"Protection" as a principle can therefore find no place in the general tariff system which will be substituted for that devised by McKinley and repudiated by the American people. In the adjustment of a revenue tariff the result of many an item will, indeed, be such as can and will be taken advantage of by the domestic manufacturer to exact an extra bonus from his fellow-citizens. He will, however, no longer be listened to when he asks that the tariff be adjusted to that end. His protection, if he receives any, will be accidental rather than even incidental,—such as, after the tariff has been adjusted for revenue, he may find, rather than any which by adjustment he may seek to obtain. Such favoritism as is still thus left will be immaterial when compared with that deliberately provided by our present laws, and simply one of the evils which can be redressed only by abolishing tariffs in favor of other means to raise revenue. These means have their special objections as well ; and while the Democratic party is not committed to the use of the tariff as a resort for revenue, yet, on the other hand, it is not committed to its abolishment.

That raw materials will be relieved entirely from tariff taxation, and that partially manufactured materials for further manufacture will be subjected to merely nominal or low duties, is certain,—the former by the direct promise of the platform, and the latter as involved in its principles.

As to manufactured goods of general use, there will be imposed on them no duty other than a very moderate one. This follows especially from two considerations :

I. In the first place, these are the articles, generally speaking, as to which facilities of production are enjoyed by one or more foreign countries in common with our own, and the fact of considerable imports under any circumstances rises, therefore, rather from some comparatively immaterial and often temporary advantage utilized

by the foreigner than from causes which make it wholly or permanently impracticable for the home manufacturer effectively to rival him; and with the removal of the duty on raw materials and the reduction of that on partially manufactured articles, our home manufacturers will be still more nearly and promptly on even terms with their foreign rivals. In most cases, therefore, a high rate would be so largely prohibitory as to reduce the probable revenue below that to be secured by a much lower rate, which would permit comparatively liberal importation.

II. Again, there is an even better reason why high duties on manufactured goods which enter into general use can form no part of the new tariff; the framing of which, as must constantly be kept in mind, will be guided by the fundamental principle that the federal government has no constitutional power to impose tariff duties except for purposes of revenue only.

It is easy to quibble over this; but there is no question as to what the average citizen has a right to understand by it. It means that taxation must be justified by its revenue results, and by them alone. If these results are such as to justify any item, if the return to the government is such as to justify the extent of the exaction thereby made upon citizens, then the mere fact that incidentally, or rather accidentally, it gives an advantage to some home producer does not make the item an illegitimate one. If, on the other hand, however, the exactions upon citizens are so great as to be out of proportion to the comparatively small return of revenue to government, then not merely is the item on its face an unjustifiable one, but the fact that home producers get the lion's share of what is thus extorted from their fellows characterizes it as oppressive, and points it out as the very abuse the Democratic party is pledged to remedy.

In this connection it may also be expected that the principal tariff trusts will be struck a fatal blow by making their products free of duty. This is not merely in accord with the general condemnation of trusts, which was included as a plank in the Chicago platform, but is involved in the fundamental tariff principle already quoted. For to the precise extent that a successful trust secures monopoly of a tariff-protected article, its practice uniformly is so to adjust its prices to the importing rate as, while taking advantage of the protection thus afforded, fully to supply the home market and thus to leave the government without revenue from the tariff on the article in question. The tariff item thus treated becomes demonstrably

not one essentially of revenue, and therefore must be abolished as an unconstitutional exaction. For example, the one-half cent per pound on the total amount of refined sugar used in this country, which is added by the McKinley tariff to the profits of the sugar trust, but which produces no revenue worth mentioning, will find no place in a Democratic tariff bill; while the revenue from the tariff on window-glass, being regulated by the trust which controls that product and which naturally keeps for itself the greater part of what the people are made to pay, is another example of the tariffs that "must go."

The new tariff law will also be much more simple than is the present one. So long as the question was one of the distribution of government largess to those claiming the right to tariff "protection," the theoretical tariff must be as complex as is the development of manufacturing industries with their infinite ramifications and interdependencies; and a tariff scheme on this theory, however defective, was a labored series of the permutations and combinations of personal and political considerations affecting either separate classes of manufacture, on the one hand, or members of Congress, on the other. But when revenue is the exclusive end to be subserved, and it is remembered that no system of taxation devised by man can be made to bear with perfect equality on all affected by it, and that tariff taxes are by nature uncertain and unequal in their final incidents, there will remain no reason for even attempting to adjust their burdens, except on broad lines and so as to keep resulting inequalities within reasonable limits. This simplification will probably include a great extension of ad valorem as compared with specific rates of duty, this (1) as a comprehensive alternative to elaborate grading in specific rates, to secure substantial equity of taxation, and (2) to obviate fraud. The former is so well understood as to need no explanation here. As to the latter, a word may be justified:

It is easy to suggest that, if an article *X* is subject to a specific duty *A*, there is no inducement for undervaluation by the importer. The actual examples, however, are much like these: Upon the article *X*, "provided it contain not more than 15 per cent. of alcohol," a duty of fifty cents is levied, and, provided it contain more than 15 per cent. of alcohol, $1 is levied; or on goods valued below 50 cents per yard 40 cents per yard is levied, and on similar goods valued between 50 cents and $1 per yard 80 cents per yard is levied, and upon all goods valued over $1 per yard $1.50 per yard

is levied; or upon specified goods of less than so many threads to the inch a duty is fixed at 20 cents per yard and increased to 40, 60, and 80 cents according as the number of threads per inch passes certain arbitrary limits; or it is provided that specified goods "not suitable" for certain uses shall pay a certain duty per yard or pound, but, if suitable for these uses, they shall pay double that rate; or that certain articles "not commercially known" by a given term shall pay a certain duty, while if commercially so known they shall pay a different duty. These illustrations might be extended indefinitely, and, when combined with the "minimum" rate provisions, or "compounded" of ad valorem and specific rates, are hard to comprehend by other than tariff experts.

Indeed, the possibilities of evasion of duties are indefinitely multiplied when the fraudulent valuation, count, or estimate is effected by adding an extra thread, mixing a petty per cent. more of an ingredient, or slight prevarication as to comparative fitness for certain uses. Taking the treasury cases, one sees at once that it is not by questions rising on ad valorem duties that custom-house inspectors are mainly occupied and our court dockets filled with adjudication of revenue frauds, but that it is in the cases which rise under specific duties that this trouble occurs; and the extension of the ad valorem system will therefore subserve the ends of convenience as well as those of equity.

It is not possible here to discuss even briefly many of the more important of the single items involved. It may, however, be proper to note a few, presumably of special interest to the constituency of this Magazine.

It may be expected that iron ore will be put on the free list. It is a typical so-called "raw material," hence certain to be so treated by Democrats who believe in promptly carrying out the Chicago platform. Moreover, with the development of the Vermillion and other iron ranges, including the Giant Messaba, the competition for the supply of the western and central portion of our country is finally settled about Lake Superior as compared with the seaboard slope east of the Alleghanies. In other words, the section that but shortly since procured "protection" in order to enable it to control the extending market afforded by our country's development now sees this market exploited by those who, except for the more inviting new worlds yet to be conquered in the West, would drive the East from its home fortresses. As a result, the eastern seaboard is abandoning the attempt to control the west-

ern market for bulky iron products, and is anxiously devising economies and facilities to hold its own market in this regard, while still extending its sales of the more specialized lines of manufacture; and the capital and local interests of New England, New York, and New Jersey, which have for years demanded relief by free raw materials, are now being reinforced from Pennsylvania, Maryland, and West Virginia.

With coal, somewhat similar conditions are adding daily to the interests to which free coal is a longed-for advantage; and in this case the relations of our western coal-fields with central Canada are such as to offer the further inducement of a far larger foreign market for Mississippi-valley coal by reciprocity in this respect than would thus be given in the United States to the coal of the Canada seaboard; while our Pacific States are at the same time finding it more and more desirable to secure cheaply the coal of British Columbia.

Though logically not so urgent, yet the extent to which the interest that would still shut them out is becoming plainly confined to a few, who wish to monopolize the advantages of the riches which, in their opinion, the Almighty has too generally distributed, to the direct detriment of a far greater number both of capitalists and laborers among their own countrymen, bids fair to secure the admission of silver lead ores either free or at a nominal duty.

These so-called "raw materials" being put on the free list, or admitted at nominal duties, a substantial reduction in duties on manufactured goods would follow. For it would be an indefensible increase of "protection" to leave untouched the present rates on manufacture while taking the duty from raw materials.

Similar considerations apply to the wool schedule. Not merely has the number of those who believe themselves interested in cheap woolens, as distinguished from dear wool, steadily so increased that the latter are a disappearing minority, but even they are beginning to appreciate that their only hope for a good wool market lies in promoting wool manufacture by free foreign wools rather than attempting to add to its profits by high duties.

Free wool will involve a reduction of the duty on manufactured woolens. Protectionists have had their day in chuckling over their witty suggestions of absurdity in the idea that tariff reformers are striving at once for a better market for wool and cheaper woolen goods; and the mass of our citizens are beginning to appreciate—what every business man understands—that at the center of every

manufacture are its raw materials highest in price, and its products the cheapest and best.

To-day the United States is the largest consumer of woolen goods upon the face of the globe, and we are using a constantly larger proportion of all woolen goods made in the world. In addition, we are the only nation whose consumption of these goods can be regarded as considerable and whose wool product is so great a factor in the world's stock of wools. We are so situated also as under natural conditions to avail ourselves of the world's growth of wools to as great an extent and as easily as any other nation. The industry of wool manufacturing long ago reached the point where it involved just those factors of ingenuity and enterprise in which we, as a people, are most prominent. Under natural conditions, therefore, not in London, but in New York or Philadelphia, should be the great wool market of the world—where wools of every class and grade should be worth more than at any other place. It is here that should be centered the wool manufacturing business of the world; and instead of importing so large a proportion of the woolens which our people use, we should be exporters to all quarters of the world.

I may be asked my grounds for believing that such a policy as I have outlined can be enacted into law. It is less radical, when compared either with the general drift of public expression or the official utterances of the party, than was the Mills Bill when it was presented. It will be pressed by the added pertinacity and force that have been developed by the demonstration of the elections of 1890 and 1892 that it is the popular will. Its opponents will have lost from the serried lines of monopoly, that were so nearly routed six years since, the time-servers who then thought they were on the winning side, the growing body of manufacturers who have lately tasted the ashes of the Sodom apples of protection, and the rapidly growing number of those who appreciate that even successful resistance now would only further deplete their own ranks and add to the overwhelming demand for a still more radical measure.

As to our export trade, the first effect of a reduction of tariff taxation will be largely to reduce the cost of those manufactured goods that are the necessities of life to a civilized people. As a result, the people will purchase more of them. Such is the object of tariff reform,—to help each to get more of everything he wants. This increased demand will be divided between home manufacturers and foreign ones. On the one hand, we will import more

goods than we now do, and at the same time we will manufacture and market at home more than at present. The greater the freedom of commerce, the greater the advantage secured the energetic, the enterprising, and the far-sighted manufacturer, and the more promptly his incompetent and illiberal rival is sent to the rear This weeding out of weak concerns by the sharpened rivalry of the really strong ones will be one of the most beneficent results of the impending legislation.

This, however, is not the greatest advantage certain to come from freer commerce. Our imports will increase at the same time as will our consumption of home manufactures. This will stimulate exports, and our agricultural products will be given an increased market. Nor is this all. Raw materials made free, our manufacturers will in great measure find that even at the reduced price of their products their profits are as great as now; while to those among them who have the enterprise to exploit it will be thrown open a wider field for the export of their product. This country, with the greatest natural advantages vouchsafed to any nation, is inhabited by the most enterprising and industrious people in the world. With freer commerce the United States will more and more dominate the rest of the world in manufacturing.

A probable consequence of the tariff reforms about to be adopted is the exploiting of new sources of revenue. For it is as unlikely that without reimposing taxes upon sugar, coffee, and tea (which is politically out of the question), or imposing duties upon manufactures in general use at so high a rate as to make them essentially protective (which would be a breach of faith), we can meet the expenditures of the next few years, as it is undesirable that comparatively permanent taxation should be adjusted to the extraordinary but temporary demands of the treasury. Congress may therefore be called upon to choose between several expedients: the issue of deficiency bonds from year to year till they can be cancelled by surplus revenue later accruing, or the imposition of an income tax, which universal experience has shown to be the exaction most easily adjusted from year to year without risking the business interests, having each been suggested from many quarters. The well-grounded prejudice against the incidents of an income tax, albeit its comparative fairness is universally conceded, would seem to indicate that the former expedient would be deemed preferable, especially in view of its special advantages, too obvious to need discussion here.

II.

Less involved in long-standing party pledges, but in public interest from time to time frequently approaching the tariff, is the silver problem. This was recognized in the Chicago platform by three promises in such regard: (1) that the Sherman act of 1890 shall be repealed; (2) that, while the coinage of both silver and gold shall be "favored," yet the dollar units of both metals shall be kept on parity, *either* by coining them of "equal intrinsic and exchangeable value," *or* by "international agreement," *or* by "legislation"; and (3) that the prohibitory 10-per-cent. tax on State-bank issues shall be repealed.

Though as to incidental questions there may arise serious grounds of difference, yet in essentials the course to which the Democratic party is pledged is clear. Looking at these essentials only, it is, I believe, true that so overwhelming is the conviction of the party in accord with its promises, and so considerable is the extent to which the business interests and political common sense of the country are in accord with it, we may expect these essentials to be enacted into law. The Sherman act will be repealed; and, probably as a twin measure or by the same bill, federal inhibition against State-bank currency will be abandoned under conditions which will leave to the government the least administrative power necessary to secure soundness of such State-bank notes as are issued, leaving their amount to be regulated by the needs of local business, and their elasticity to meet the demands of commerce.

As to the remaining question, free coinage of both silver and gold will be "favored" as far as is possible within the alternatives described by the Chicago platform. Should it be possible by international agreement to assure a stable ratio between the two metals, the Democratic administration may be trusted to facilitate this, and a Democratic Congress to enact the necessary legislation. In event of the failure of international agreement, should federal legislation be devised equal to the situation, Congress will promply enact it; and in default of both these expedients, then, if any considerable body of our citizens claim the fulfilment of our platform pledge by legislation that shall require gold and silver to be coined from time to time at such a ratio that the coins issued at any time of either metal shall be of "equal intrinsic and exchangeable value" to those of the other of the same face value, it would be the duty of Congress to consider such legislation,—though so improbable is it as scarcely to justify its present consideration.

GREAT BRITAIN AT THE WORLD'S FAIR.

By James Dredge,

British Royal Commissioner.

IN my opinion the British section at the World's Columbian Exposition will do full credit to neither England nor Chicago. Facts may, and I hope will, show that this opinion is incorrect; but, even should the section develop into a brilliant success, it cannot fulfill the highly-colored predictions concerning it with which the newspapers, and especially the Chicago newspapers, were flooded some time ago.

What I wish especially to emphasize is this: that neither by American nor by foreign visitors and customers must the display in the British section be regarded as representative of the industries of England, but rather as the best that could be done by an energetic royal commission to induce a certain number of British manufacturers to take part more or less completely in the great show at Jackson Park. As regards the number of exhibitors, Great Britain does not compare favorably with the part she played at the Centennial at Philadelphia in 1876, and, although she has a far larger allotment of space at Jackson Park, yet in Philadelphia she occupied one-seventh of the total covered area, while this year she will occupy less than one-fifteenth. It may be assumed from this that Great Britain has not held her own in the Columbian celebration. Approximately we have (apart from the fine arts) 580 exhibitors in all classes of industry,—a very poor total as regards numbers, though this deficiency might be compensated by the high class of exhibits—a point we will examine generally later on. The following table gives only approximately the area in square feet that has been allotted—always in the best locations—in the various buildings and the number of exhibitors:

Department.	Square feet.	No. of Exhibitors.
Agriculture	14,176	75
Horticulture	656	18
Fisheries	1,300	11
Mines and Mining	8,000	33
Machinery	40,000	56
Transportation	54,257	80
Manufactures	100,400	191

Liberal Arts	64,240	103
Electricity	8,289	11
Woman's Building	2,384	...
Forestry	1,700	2
Fine Arts	20,325	...
Total	315,727	580

[In the Fine Arts Building there are 1130 pictures shown, and in the Woman's Building there are quite a large number of entries in the catalogue.]

Very briefly I may endeavor to analyze the nature of the objects comprised in the foregoing list, but this summary must necessarily be regarded as imperfect.

In Agriculture (Department A) we have mustered some 73 exhibitors, including two in the Forestry building—the Bombay-Burmah Trading Corporation, and the Indian Government, both showing specimens of teak, padouk, and other woods. One of our most promising and attractive exhibits—that of the London and Provincial Dairy Company—has been lost to us and to the exhibition, the facilities offered to the company not having been considered commensurate with the outlay and trouble involved. Whiskey, mineral waters, meat essences, and malt liquors make up more than forty out of the seventy-three numbers in this section. Of considerable interest will be the display of the British Beekeepers' Association, and the model of the Burdett-Coutts Brookfield stud-farm. Exhibits of agricultural machinery are absolutely wanting, and little or nothing in the way of cereals can be expected from a country dependent upon foreign sources for the greater part of its bread-stuffs.

Horticulture (B) in the British section is doomed to failure, and, considering the large and ever-increasing trade with America in this choice industry, the absence of many well-known exhibitors is inexplicable. British horticulture is not fairly represented by jam and condiments, and the credit of this industry, in which we take so great pride in England, must depend upon the extent of the display made by Bull & Cannell, Carter, Kelway, Laing, and Waters.

In Department C—that of livestock, domestic and wild animals—we are promised two exhibits, both being incubators. I do not think it strange or unreasonable that British stock-raisers should have declined to incur the risk of transporting valuable beasts to Chicago and of keeping them there with the prospect of an enforced sale at a depreciated value at the end of the exposition.

The eleven exhibitors in Department D—that of Fisheries—may be dismissed in a very few words; two or three models of smacks and trawlers, rubber boots and waders, fish-hooks, eel-traps, and feathers and flies comprise our contribution to this industry, in the which we are infinitely behind the United States.

In Department E (Mines and Mining) we make a very unsatisfactory display. The section is filled as follows: A cabinet collection of economic minerals comprising a great number of specimens arranged with much care by Mr. Bennett H. Brough; a few specimens of fuel—cannel, smokeless and steam coal, coke, and compressed blocks; some plain and enameled slate; granite, fire-clay, fullers' earth, and china clay; Portland and other cements by five exhibitors; salt by three exhibitors; while the metallurgy of iron and steel and its products is represented by steel bars, castings, and forgings sent by Jessop & Sons, of Sheffield, and by a few articles from the Low Moor Co., of Bradford. Messrs. Johnson, Mathey & Co. contribute specimens of platinum and platinum goods.

In the Machinery Department (F), where we have a large space for our fifty-eight exhibitors, a few objects of very considerable interest will be seen. Messrs. Galloway & Co., of Manchester, and Messrs. Willans & Robinson, of Thames Ditton, both send fine specimens of engine work. The latter, indeed, have promised three engines, one of 300 horse-power, driving a Siemens two-pole dynamo direct at a speed of 350 revolutions per minute. Messrs. B. & L. Massey's display of power hammers may be good, and the textile group will be comparatively strong, comprising nine well-known makers, several of the front rank. It is in this group that Messrs. Platt Bros. & Co., of Oldham, make a fine show of cotton cleaning, carding, and combing machinery, which will not only attract interest, but should certainly lead to extensive business results for the exhibitors.

The Transportation Department (G) with its eighty exhibitors will probably be the most satisfactory part of the British section. English locomotives and rolling-stock, including the historical "Lord of the Isles," will attract much interest, but the models of marine engines and vessels form the leading feature. Nearly twenty of the leading British marine engineers and steamship companies are well represented. In this department at least we need not, I think, be ashamed of our participation, though from all appearances we shall be greatly inferior to Germany. It should be

mentioned that one firm of steel-makers exhibit in this building,—Messrs. John Brown & Co., who show an armor-plate.

It would be beyond the scope of this brief summary to analyze the one hundred and ninety exhibits in the Manufactures Department (H). Part of such a summary would, as usual, be a long story of fancy soaps and essences, colors, varnishes, wall-paper, etc. Some sixteen manufacturers represent furniture and internal house decorations, and these, with the furniture and fittings of Victoria House,—the headquarters of the Commission,—should be good enough and important enough to leave a permanent mark on the corresponding branches of American art industries. In ceramics the names of the Coalport Co., Doulton & Co., Daniells, the Worcester Royal Porcelain Works, and one or two others, are an ample guarantee that in one point at least the British section will rank high, and with almost equal confidence it may be asserted that in precious metal work the Goldsmith and Silversmith Co. will uphold the credit of the British craft against all comers. Textile fabrics will be represented by almost twenty exhibitors; clothing by sixteen others; lace and artificial flowers by a few more; and so forth. But the glory of the department is centered in the ceramics and the display of gold and silver ware.

The less said about Department J—Electricity and Electrical Appliances—the better. Apart from Mr. Preece's most interesting collection of historical telegraphs and electrical instruments (if it arrives), there does not seem to be a single entry worthy of being displayed anywhere. Parsons's steam turbine and dynamo, the only serious and novel exhibit, has been withdrawn, leaving the section absolutely barren.

In the Liberal Arts Department (L), including education, literature, engraving, public works, music, and the drama, we have about 100 exhibitors, and in addition quite a fine collection of amateur photographs. In this department there are six exhibitors in the hygiene group; three in surgical apparatus; six in primary, secondary, and superior education; about thirty in literature, books, journalism, etc. It was in this group that was included the Stratford-on-Avon house of the *Illustrated News*, but this fine exhibit has been withdrawn. We have about twenty exhibitors of instruments of precision, cameras, lanterns, etc., and it is well to see the names of Grubb, Ross, Watson, Baker, and Beck in this group.

Really great things may be expected from the Fine Arts De-

partment, and the collection of works of British artists will far surpass anything that has ever yet been seen in the United States. The last display of British Art took place at Fairmount Park in 1876. The collection within the Art building at Jackson Park will comprise examples of the most famous living British artists and should do much to raise American appreciation of their work. The Fine Arts Committee appointed by the Royal Commission may be congratulated in advance on the way in which its work has been done.

From the foregoing brief analysis it may be reasonably deduced that England will have full reason to be satisfied with her Fine Arts display; that a handful of British exhibitors will stand high in the Manufactures and Liberal Arts Building; that in the Transportation Exhibits Building the British section will be as a whole satisfactory, and in some respects remarkable. But that in the Agricultural, Electrical, Mines and Mining, Fisheries, and Horticultural, our exhibits, where they are not contemptible, will be at least insignificant. The question naturally arises, why, on this great battle-ground of commerce, England has refused to push forward any considerable force of her manufacturing army? And why in this, which will be probably the most important, as it is certainly the largest, exposition the world has seen? The answer is found partly in the fact that English manufacturers in general have not considered that it would pay them to incur the expense and trouble of exhibiting so far from home; partly because of the prejudice and hostility that existed against "McKinleyism"; and partly because the actual facts of the case were not brought clearly enough before the possible exhibitors, who care little for official circulars and require conviction by personal arguments,—a long and very tedious process, which I believe has been most successfully practised in Germany.

Englishmen have not realized the vast influence which the Columbian exposition will have on the trade of the world in the immediate future, and probably for many years yet to come. They resent the policy that has so largely helped to develop American industries and manufactures and to increase her wealth, ignoring the fact that in spite of tariff barriers the United States are by far our largest foreign customers, and therefore most worthy of being studied and encouraged. They ignore the fact that Germany and other manufacturing countries jealously regard our trade with the United States and intend to take from us as much as they

can get, and towards which entirely justifiable end the Columbian exposition will be an invaluable means. "McKinleyism" is a parrot cry that has resounded through the length and breadth of England, and has successfully stayed the energy of British manufacturers, to their future loss and to the permanent gain of America, Germany, and other dangerous and ever watchful competitors.

However, for good or ill, the part to be played at Chicago by England is now fixed, and if I have drawn a somewhat gloomy picture, it is because I wish as early as possible to enter a protest against those trade competitors who may endeavor to spread the belief that the British section fairly represents the manufacturing power and glory of Great Britain.

I ought to add a few words to explain clearly the organization by which the interests of Great Britain at Chicago are controlled. Originally the British government limited their grant to £25,000, a sum obviously inadequate to pay the necessary expenses. South Kensington declined to accept the responsibility for less than £60,000, and consequently the Council of the Society of Arts, a highly representative body, was invited to act as a Royal Commission. The invitation was accepted and the warrant for a Royal Commission was issued in August, 1891. It was the intention to make up the inevitable deficit by charging a rental to exhibitors for space, but when later the government increased the grant to £60,000 this undesirable necessity ceased. It need hardly be said that the members of the Royal Commission, numbering about thirty-five, are entirely unpaid officials, and they have devoted much time and labor, and some of them very considerable expense, in promoting the welfare of the section. Of course a paid executive staff was necessary from the commencement to carry out the instructions of the Commission, and as chief of this staff Sir Henry Trueman Wood, who has for a number of years occupied the post of secretary to the Society of Arts, was selected by the Commission. Some other members of the staff are Mr. H. B. Wheatley, assistant secretary, Mr. E. Loyd, general superintendent, J. W. Beck, E. H. Fishbourne, and T. H. Wilkinson, superintendents of Fine Arts, Manufactures, and Machinery respectively. The greater part of the executive staff will remain at Chicago during the whole period of the exposition, and it has been arranged that the Royal Commission will be actively represented at Jackson Park for the ensuing six months, a sufficient number of its members having volunteered for this purpose. To Mr. Walter H. Harris, late

sheriff of the City of London, and myself fell the honor of first representing the Commission, and Sir Edward Birkbeck and Sir Douglas Galton are shortly expected in Chicago. Sir Philip Cunliffe-Owen, whose name is known and honored throughout America, was to have accompanied us, but at the last moment he was struck down with illness.

It has been my peculiar privilege to be closely associated with the Columbian Exposition from its inception, probably more closely in an honorary sense than any other foreigner, and the success of the undertaking as a whole is a matter that I have very much at heart. I can of my own knowledge testify that Chicago earnestly desired the fullest coöperation of England; she gave her throughout the best locations, the fullest advantages, the greatest space that could be afforded. If we have not seen fit to avail ourselves of our opportunities, the fault is ours, not theirs, and I cannot help feeling that, if facts had been more forcibly brought home to our manufacturers,—if for example our newspapers had shown a broader and more unanimous spirit than they have done,—Great Britain would have taken her proper place at the head, and far in advance, of all other foreign nations. The individual spirit of kindness and good will in England towards America is not wanting (though perhaps it lies somewhat below the surface), as I have had ample occasion to ascertain in my private and not unsuccessful efforts to form a loan collection of objects connected with transportation, for my friend Mr. Willard A. Smith of the Transportation Exhibits Building, and the royal interest taken in the great celebration at Jackson Park is proved by the fact that Mr. Walter H. Harris has been intrusted with a fine series of Windsor tapestries as a loan to America. In this connection I may add that Mr. Harris is offering to Mr. Higinbotham, the president, as a loan, his splendid, indeed almost unique, collection of British war medals.

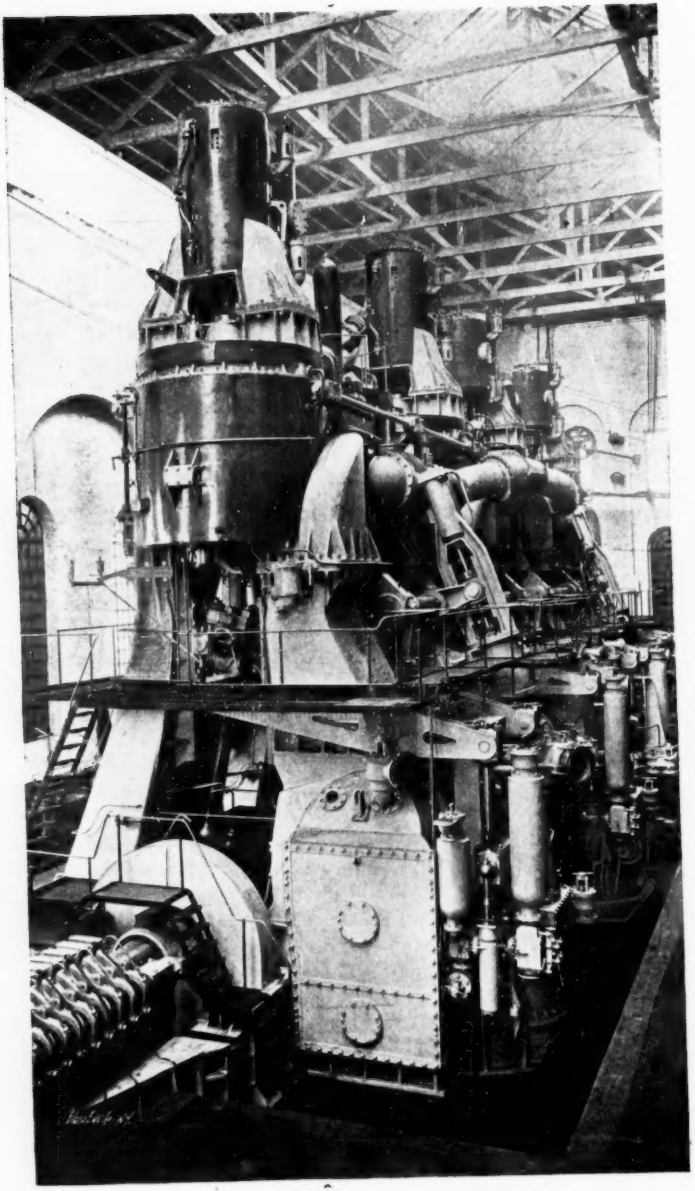
THE LATEST AND GREATEST CUNARDER.

By a Clyde Engineer.

BY the time this Magazine is in the hands of its readers the new Cunard liner *Campania* will have arrived at New York, and much will doubtless have been written in the daily press about her performances on trial as well as on the Atlantic. That she is the embodiment of the most advanced practice in marine construction is universally admitted, and, although I am at the time of writing unable to prophesy her performance on the Atlantic, I may hazard the remark that she has surprises yet in store for the public.* As in the human system, so with the marine engine, a little training makes the joints supple. Thus it is that no steamer has broken the record in its maiden transatlantic trip. It is true the *America* did excel all previous performances in her first voyage, but it was on the way back to England after she had had a week of training on the Atlantic in addition to the trial cruises. The *Campania's* engines have power in reserve to create surprises. And here the remark suggests itself that the machinery of the *Campania*—as of all steamers—is her most interesting feature. Without the engines she would indeed be lifeless,—beautiful as the conception of Venus by a master mind, but still inanimate.

The engines of the *Campania* and of her consort *Lucania*—names, by the way, taken from the old provinces of ancient Italy—are of the five-cylinder, triple-compound type first introduced into the North German Lloyd steamer *Lahn*, also built at Fairfield, and now fitted for the first time into twin-screw steamers. The advantage is that great power may be developed without an unduly large low-pressure cylinder. Thus in the *Campania* over 30,000 horse-power has been indicated, and yet the low-pressure cylinders are each only 98 inches in diameter. There are two high-pressure cylinders of 37 inches diameter, one intermediate cylinder of 79 inches, and two low-pressure cylinders of diameter above named, the stroke in each case being 69 inches. The high-pressure cylinders are placed above the low-pressure cylinders with the ordinary sleeve

*This paper was written in Glasgow before the *Campania* started on her first transatlantic voyage. An account of the record made will be found this month in the department of "Mechanics."—THE EDITOR.

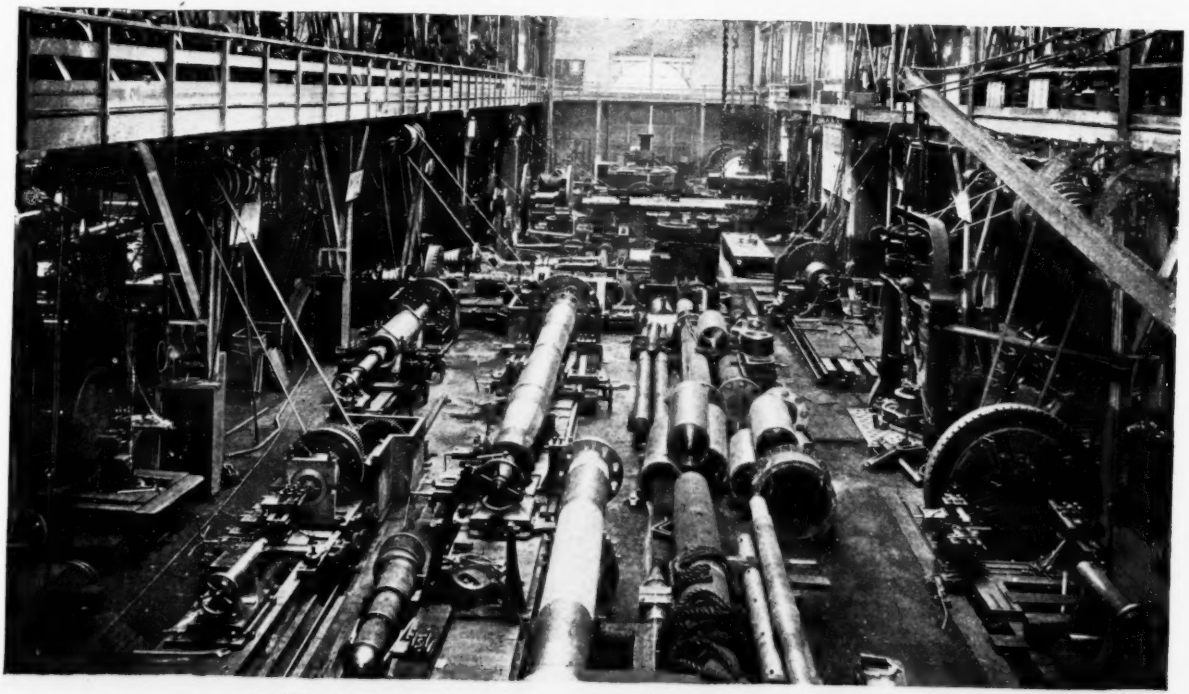


TWIN ENGINES OF THE "CAMPANIA" AS COMPLETED.

stuffing-box, the intermediate is between the pairs. This arrangement will be comprehended from the engraving of the engines completed, shown on another page. The engines were finished in a remarkably short space of time. The order was not given till August, 1891, and yet all the details of design for the machinery had been arranged by Mr. Andrew Laing, the engineering director at Fairfield, patterns made, and the first of the castings and forgings delivered in the machine-shop before the end of September. Before the close of the year the bed-plate, frames, condensers, and the three-throw crank-shaft of one of the engines were erected in position in the fitting-shop. There were lively times at Fairfield at the beginning of 1892. All the immense machine-tools were in active operation; and here it is interesting to note that much of the work was milled with tools designed on the principle of those largely in use in American works. The condition of the machine-shop at the end of March was significant of industry, and two of the engravings accompanying this paper are views from opposite ends at this time. Immense cranks weighing 27 tons; 24-feet lengths of 26-inch propeller shafting; huge cylinder liners; valves; piston-rods; connecting-rods; and eccentrics of something like five feet in diameter lie about like,—well, like scraps of paper on the floor of an editor's room. Yet a careful examination suggests evidences of system, without which the work could not have been advanced so speedily.

About this time, too, the two engines of the *Campania* were in a forward condition. Everything was ready for placing the cylinders in position, the connecting-rods lying loose to join up to the cross-head, while the air-pumps were completed and in place. The thrust-shaft was also in its bearings. Three months later, or at the end of June, the two engines were completed, for at this time the photograph reproduced on page 289 was taken. Nor was this despatch at the expense of other work, for the engines of the *Lucania* were well in hand, ready for the placing of the condensers, while at the same time the establishment was completing the engines of another twin-screw steamer for the channel and a 19½-knot paddle-steamer. In fact, there was in June last, on the floor of the fitting-out shop at Fairfield, engines which aggregated something like 70,000 indicated horse-power, probably excelling the total in any other works at one time. This, apart even from the long list of successes in engine design, testifies to the efficiency of Mr. Laing's management. His skill and aptitude as a designer

MACHINE-SHOP AT FAIRFIELD, DURING CONSTRUCTION OF "CAMPANIA'S" ENGINES, MARCH, 1892.

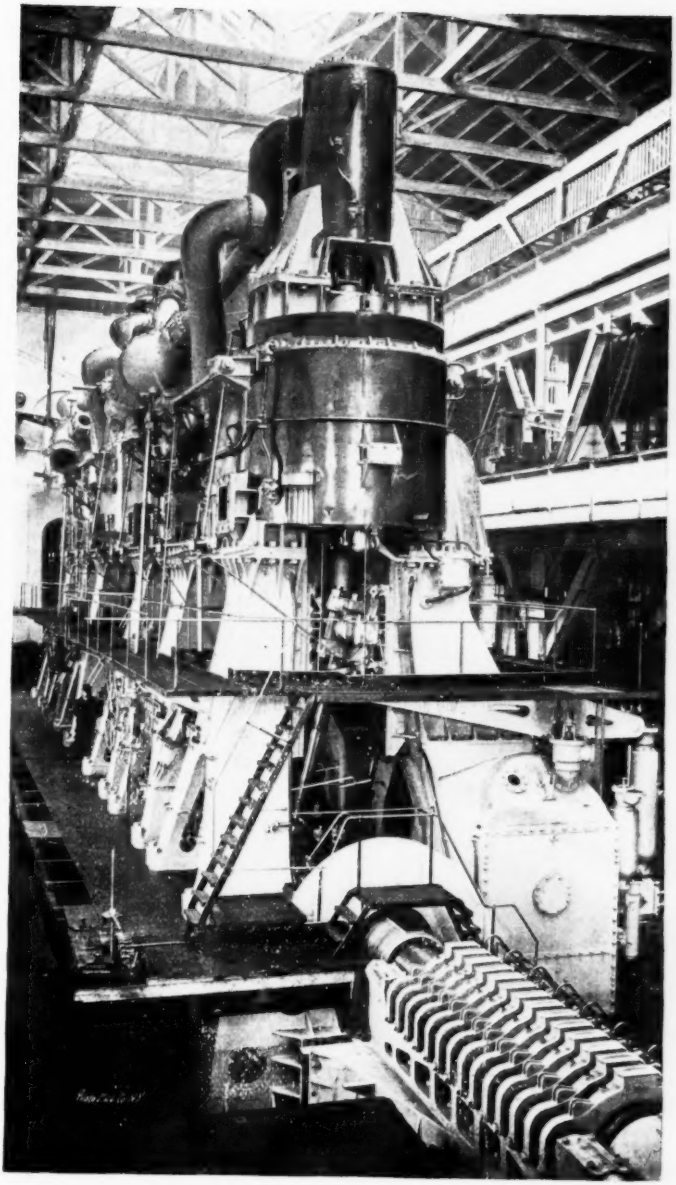


MACHINE-SHOP AT FAIRFIELD DURING CONSTRUCTION OF "CAMPANIA'S" ENGINES, MARCH, 1892.

have been acquired by long experience at Fairfield, where he has been since 1877, and where for the past thirteen years he has been responsible for the design of engines for all types of steamers and war-cruisers, built at the Fairfield company's famous establishment at Glasgow.

The engines which Mr. Laing has not only designed and constructed, but has tended during their first task of bringing the leviathan across the Atlantic, stand 47 feet high. A piston-valve is fitted to each of the high-pressure engines, and slide-valves to each of the others, one valve gear being the usual double eccentric and link-motion. The condenser is in three parts, and is divided into two sections, each low-pressure cylinder exhausting into different sections. The circulating pumps are worked independently and the engine for driving them is of the compound type; but it is so arranged that it may be worked as a high-pressure engine,—both cylinders getting steam direct from one boiler,—so as to develop a higher power for bilging out. The air-pumps are worked as is usual by levers from the crossheads of the forward and aft engines. The crank-shaft is in three interchangeable parts, set at the usual angles, each part weighing 27 tons; and with the thrust-shaft, which is 14 feet long, the crank-shaft weighs in all 110 tons. There are 14 rings of the ordinary horseshoe type tied direct to the foundation of the engine. The propeller shaft is 26 inches in diameter, and the three blades of each screw are of manganese bronze, each weighing 8 tons. The stern of the vessel has been bossed out so that outside shafting has been dispensed with, the shaft being carried right aft inside with a bearing close up to the propeller. This arrangement is seen on the engraving of the stern of the vessel. Every safeguard against possible contingencies has been provided, and among these may be noted emergency-gear fitted in connection with the steam and hydraulic starting and reversing engine, whereby the engines are automatically stopped when they exceed a given number of revolutions, determined according to what is regarded as the limit of safety. Before adoption the efficiency of this gear was thoroughly tested; and since it was fitted it has been worked with most satisfactory results.

There are fourteen boilers in the *Campania*, having in all 102 furnaces. Twelve of these are of great size, the largest made to work at 165 pounds pressure, or even higher pressure. Some of the plates worked into them measured 20 by 7 feet and were over $1\frac{1}{2}$ inches in thickness. The twelve large boilers are double-ended,

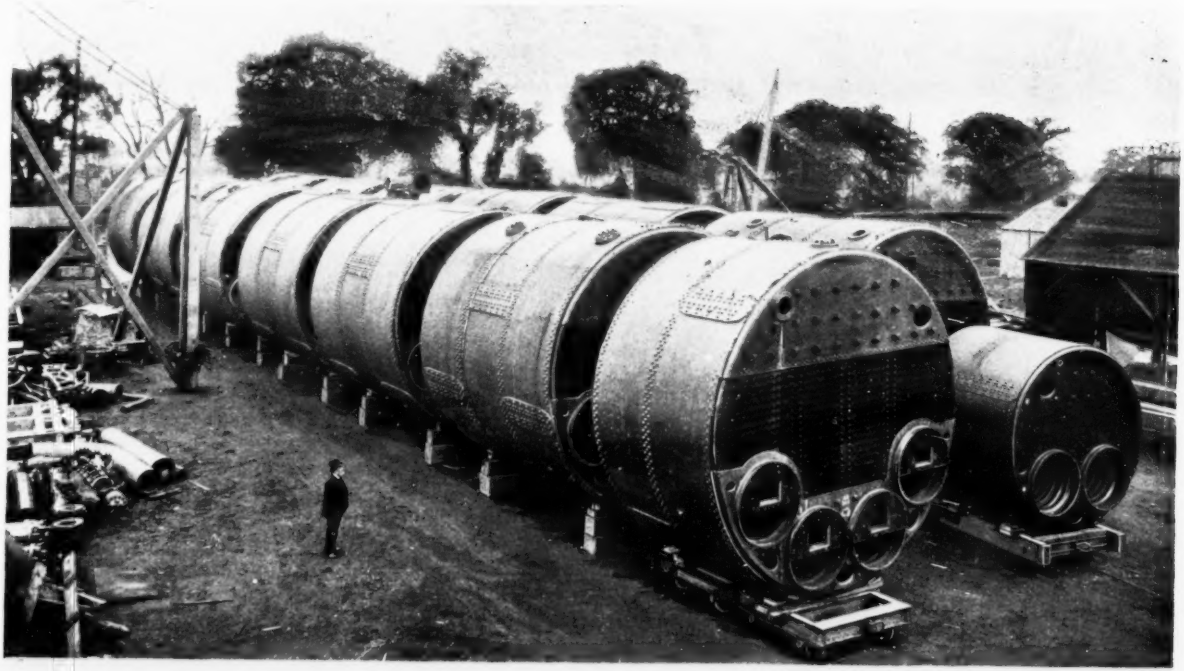


TWIN ENGINES OF THE "CAMPANIA" AS COMPLETED.

18 feet in diameter by 17 long, each with eight furnaces. There is a combustion chamber common to each pair of furnaces. One of the smaller boilers is for auxiliary machinery, and the smallest for donkey purposes; but all may be used for propelling the vessel, if desired. The boilers are shown in a group in one of the engravings. In the ship they occupy two large water-tight compartments separated by a large compartment given over to the carrying of fuel. This bunker is 60 feet long and the entire width of the ship, so that when the vessel comes to be used as an armed cruiser by the British admiralty, for which purpose she gets an annual subvention, she will not only have great speed and seaworthiness in her favor, but long coal endurance. There are two funnels about 130 feet apart. Great as is the ship, the enormous diameter and height of these funnels are impressive. The diameter is 20 feet and the height from the base of the ship 130 feet. Sufficient draught is thus provided.

Unlike most of the other high-speed modern Atlantic liners, neither the *Campania* nor the *Lucania* has a forced blast to assist consumption. The stokehold is open, and only the stoker who has had one day's experience in the Gulf stream in August can appreciate the blessing of this arrangement. To still further insure free ventilation there have been provided a large number of fans working on the shade deck. The necessity of these was established owing to the openings in the stokehold being somewhat restricted to provide the requisite passenger accommodation; for, as we have already stated, the machinery occupies the best part of the ship and nearly one-half of the length. The feature of the fans is that they are driven by a new type of triple-compound engine. Each engine contains two cylinders, into which a piston having three distinct areas is placed in such a way that triple expansion is carried out in the cylinders while the pressures on the crank shaft are entirely in one direction. Weir's system of feed-heating is installed. The economy of this system, introduced many years ago, is now established, and the rationale may be briefly stated thus: the quantity of steam condensed by the feed-water represents an amount of steam which has been worked in a theoretically perfect engine, because after doing work the whole remaining heat, both latent and specific, is returned to the boiler.* Pumps and evaporators have also been fitted. The steam-pipes are of wrought-iron lap-welded; and in this departure Mr. Laing has acted with care,

* See *Engineering*, Vol. IV., p. 527.

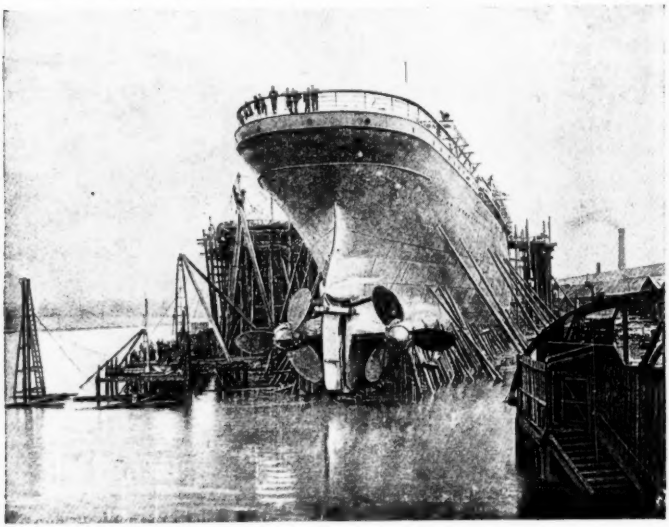


COMPLETE SET OF BOILERS OF THE "CAMPANIA."

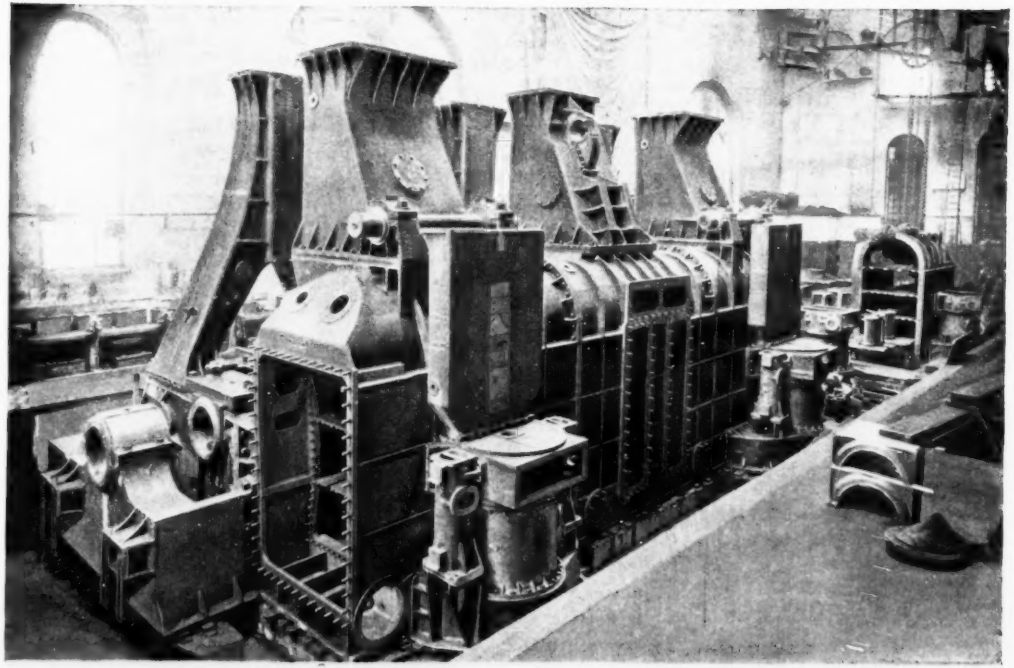
but with characteristic energy. He had many tests made,* and found that a pipe 11¼ inches bore and of metal ⅝ inches thick showed no movement, although 800 pounds pressure was applied, and did not finally burst until subjected to 3100 pounds. The pipes in the Cunard vessel are of twenty inches bore, and of $\frac{9}{16}$ inches metal.

The electric-light generating plant is placed in the main engine-rooms, which, by the way, are separated by fore and aft bulkheads. There are four engines and dynamos,—two in each compartment,—and these run 1350 lights, the current being passed from a large switchboard through about fifty miles of wire laid on the return-conductor system, in connection with Siemens's distributing-box. Any two of the dynamos are sufficient to completely illumine the ship. Each engine is designed for an output of 70 brake horse-power when running at 275 revolutions per minute, and with 100 pounds steam pressure. A notable feature in the design is that the balance piston-valve is placed centrally between the two cylinders and admits and exhausts steam from both cylinders. The governor balls are controlled by springs, and the gear is arranged to operate the single eccentric directly. As there is only one slide

* See *Engineering*, Vol. LII., p. 510.



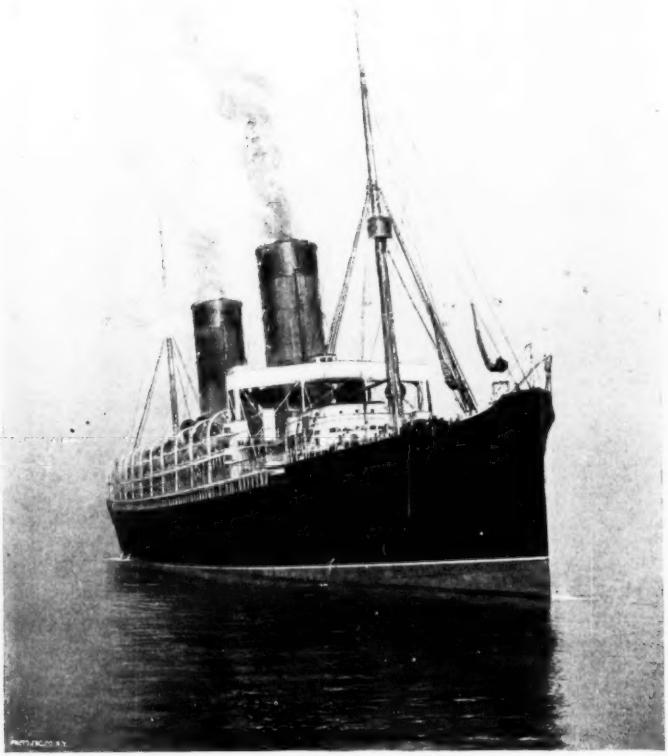
VIEW OF THE "CAMPANIA" ON THE DAY OF THE LAUNCH.



ENGINES OF THE "CAMPANIA" IN FITTING-SHOP, DECEMBER, 1892.

valve, the power in the high-pressure and low-pressure cylinders is practically equalized at all loads, which is unattainable when the governor acts only on the high pressure slide-valve. The dynamos are Siemens's high-pressure type, having drum armatures, each dynamo giving an output of 420 amperes, under 100 volts pressure, at 275 revolutions. Throughout the ship the 16-cylinder pressure unit is retained, and the number of lamps, rather than the illuminating power, increased where desirable.

The hull, while extraordinarily strongly constructed in all respects, has been specially strengthened in the wake of the machin-



THE "CAMPANIA" UNDER STEAM.

ery. The 4 feet 6-inches plate which forms, with its angular booms and stiffeners, the center line-girder of the vessel, has been increased in depth to 7 feet 6 inches at the machinery, and the two similar girders on either side at 15 feet centers are all increased in depth and weight. These five girders form the flooring of the ship and have between them intercostals. There is a double bottom, the outer being riveted to the bottoms and the inner to the upper edges of these girders. Both skins are, of course, thoroughly watertight, so that, should the vessel founder, her inner bottom would prevent the inrush of water to the interior. Besides, the space between the two floors may be utilized for carrying water ballast for trimming purposes. Sixteen hundred tons of water may be thus carried. This water, too, may be pumped in as the vessel proceeds on her voyage, if necessary to counteract the reduction in coal carried, so that the immersion of the vessel may be retained at the most satisfactory draught for high speed. The necessity for this will be appreciated when it is stated that the vessel may burn over 2000 tons of coal in a trip across the Atlantic, and will be lightened to this extent on the voyage. From the outside girders,

ANDREW LAING.*

*Mr. Andrew Laing, manager of the engine-works and also a director of the company, has been at Fairfield since 1867, and has taken an intimate and creditable part in many of the triumphs in marine construction at that point. Indeed he has since 1881—the date of his appointment as chief draughtsman—been responsible for the design of all the notable steamers built at Fairfield for the Atlantic, Eastern, and other services. With such experience it became a relatively easy matter to determine all details of design to suit the requirements laid down by the directors of the Cunard Company.

forming the base, there rise the side frames which are of the channel section, with web frames at frequent intervals, carrying the hull beams for the six decks, and the transverse bulkheads dividing the ship into sixteen or eighteen watertight compartments, so spaced that three of them, particularly those forward, might be flooded without the vessel sinking, while any two flooded would cause only inconvenience. The largest compartments are those for the boilers and engines. The shell-plates are of great size; the minimum is 25 feet by 6 feet breadth. They are scarfed under the waterline and belted and strapped above.

Although not our intention to enter into details regarding the design of the ship and the thousand-and-one little conveniences introduced by the designer, Mr. R. Saxton White, it may be interesting to mention one or two of the principal features by way of preface to our description of the machinery. As is now so well known by all who take an interest in Atlantic steamers, the length of the *Campania* is 622 feet long over all, or 600 feet between perpendiculars, 65 feet in beam, and 59 feet in depth from shade deck. There are six decks,—top, lower, main, upper, promenade, and shade. The first-class passengers are accommodated in the center of the ship, the best state-rooms being on the promenade and upper decks. There are *en-suite* rooms, one-berth, two-berth, and three-berth rooms. The ordinary rooms are on the upper and main decks, with a few even on the lower deck. The second-class rooms are located on the same deck aft of the machinery, with the poop for promenade. The public rooms are all sumptuously decorated and of great size. The dining-saloon accommodates from 500 to 600 persons. It is on the main deck with an immense well to the shade deck—about 35 feet high—for ventilation and light. The drawing-room, library, and smoking-room are on the promenade deck.

The steering-engine is entirely under water. With the exception of the American liners *Paris* and *New York*, the *Campania* and *Lucania* are the only merchant vessels of which this can be said in the truest sense of the word. The stern of the *Campania*, just above the rudder, has an annular chamber, which in outward appearance is not unlike a torpedo launching-tube. It is shown in the engraving of the stern of the vessel. From this chamber are connecting rods from the 4-feet crosshead of the rudder. These rods are 20 feet long and connect with Brown's steam-tiller steering-gear. The rudder-head is turned by means of a cast-steel tiller 17 feet long, having at its

after end a double jaw fitted with bearings, and carrying between the jaws a pinion running in a horizontal plane and engaging with a toothed quadrant bolted to the deck. The steering engine is carried on the tiller and moved round with it, receiving and exhausting steam through a double stuffing-box arrangement mounted on the axis of the tiller. All the machinery involved is a bronze worm-wheel connected by an internally expanding friction-clutch with spring relieving-gear to a steel pinion about 18 inches in diameter, working in a cast-steel segmental curved rack about 13 feet radius on the pitch-line. Auxiliary engines worked on somewhat the same principles are provided. They are geared up by cast-steel gearing with pitch wheel and chain which lays hold of the tiller. The great power of the windlass may be assumed when we state that the engine for working it indicates 600 horse-power. Only the hoods, which are of 5 tons weight, are above the forecastle deck. De La Vergne's refrigerating system has been fitted for the provision-rooms, and Kilbourn's system for the cargo-holds. Altogether, as stated at the outset, the vessel is most carefully designed and as carefully built, reflecting credit on all concerned.

F. SAXTON WHITE.*

*Mr. White, who was installed as manager of the shipbuilding department of the Fairfield Shipbuilding and Engineering Co., Limited, in 1887, with a seat at the directors' board, had a training eminently fitting him for undertaking the designing and construction of great ships. He had previously been engaged successively in the works of Messrs. Denny, Napier, Sir William G. Armstrong, Mitchell & Co., and the Barrow Shipbuilding Co., being intimately associated with the designing of ships as well as the management of the various works.

EVOLUTION OF THE IRON-FOUNDER'S ART.

By Simpson Bolland.

THE term "founding" is applied by many persons to all processes connected with the manufacture of articles in metal, whether the finished product has been forged from the malleable metal or cast in molds. This generalization is entirely misleading, and it has made all the more difficult the work of placing the origin of iron-founding as an art. Iron-founding, in its proper sense, is the art of preparing molds from plastic materials of such a nature as will successfully resist the intense heat of the molten iron,—as loam or sand,—in which may be formed the object to be produced in iron, the process being completed when the iron has been melted, run into the mold, and permitted to solidify.

Of the antiquity of working in brass and iron, as well as the more precious metals, there is abundant evidence, including mentions of the subject in the earliest books of the Bible. That the iron of the Hebrew records was not cast-iron is made to appear with much significance in Isaiah xlviii, 4 (supposed to be about 700 B. C.): "Because I know thou art obstinate, and thy neck is an iron sinew,"—the latter word being a plain indication of the quality of toughness common to iron in a malleable condition. Further evidence in support of this hypothesis is found in Psalms cvii, 16—"For He hath broken the gates of brass and cut the bars of iron asunder." A marked distinction is here observed in the methods of spoliation; if the iron had not been malleable, there would have been no necessity for the cutting. Some knowledge of smelting iron must have been known to the ancients; otherwise neither Tubal-Cain nor his Hebrew successors could have accomplished the forged-iron work with which they are credited.

An ancient method of smelting, still employed by the natives of India, is very simple and effective, probably the same as that used by the Israelites during their term of bondage in Egypt. On the whole, it is probable that, while malleable iron was in common use among the ancients, they were practically unacquainted with cast-iron and its uses; and it is more than probable that the mention of iron sculpture by the Greek writers referred to objects which had

been beaten out by hammering, and not cast in molds, as was the case, undoubtedly, in their bronze work,—the antiquity of the art of casting in bronze and the precious metals being well established. The processes employed were probably similar to the *cire-perdue* process.*

Much stress is laid on the statement of Pausanius (A. D. 120) that Theodorus the Samian was the first to discover the art of casting in iron and making statues of it, about 440 B. C.; if he was, the secret must have died with him, there being no evidence of the art at that time, extending beyond his island home in the Mediterranean. We must confess that the state of the mechanic arts then existing do not harmonize with probability in Pausanius's statement; because to mold statues in cast-iron would have demanded a knowledge of materials and a degree of skill very superior to and much more exacting than that to which statue-founders had hitherto been accustomed in the *cire-perdue* processes no doubt then prevalent. But further on he says, "To make statues of iron is most difficult and laborious," from which we are almost tempted to believe that the noble islander did accomplish something of the kind, after all, and left the world no wiser as to the methods he pursued.

As time advanced, a growing demand for implements of war, as well as for the more peaceful implements of agriculture and other domestic arts, created the necessity for improved systems of producing malleable iron for such purposes. But about the early part of the sixteenth century larger furnaces for the manufacture of cast- or pig-iron were introduced in some parts of Europe, such iron being subsequently converted into malleable or wrought iron in the forge-hearth.

A patent was granted in England about the year 1544 for a new process of making cast-iron, but works written much later than this date make no mention of castings being made from this metal; which seems strange when it is certain that castings had been made from the earliest ages from other metals and their alloys. About 1740, we are informed, iron cannon were successfully cast in the south of England by workmen who were afterwards taken across the channel to teach the Frenchmen this new art. At this time there were very few furnaces that would produce more than one ton of pig-iron per day; consequently, where the foundry

**Cire perdue* (literally, lost wax).—A French term applied to the process of bronze casting wherein the article to be cast is first modeled in wax; the wax model being then inclosed in plastic clay, upon heating which the wax melts and runs out, leaving the mold.

operations were of more than ordinary magnitude, a number of these miniature blast-furnaces might have been seen at work together.

Reaumer, the great French metallurgist, published in 1722 an interesting account of the methods then practised by him. The remelting of the pig-iron had previously been conducted in crucibles, but he conceived the idea of facilitating foundry operations by melting his metal in direct contact with the fuel, using for this purpose what may be taken as the forerunner of the cupola at present in use. A shaft was provided which fitted the top of the crucible, into which the iron and fuel were charged at the top in alternate layers; the blast, produced by two large blacksmith's bellows, was forced in at the lower end of the shaft, and maintained at a vigorous rate until the requisite quantity of iron was melted, after which the shaft was removed, the debris cleared away, and the crucible, containing the molten iron, was emptied into the molds. From this we may date the beginning of modern foundry methods.

It was not till after Reaumer's death, in 1757, that these primitive cupolas came into anything like general use, though the itinerant founders of his day evidently were not slow to discover their practicability as portable furnaces. He thus ingeniously describes these tinker-founders: "There are founders who do nothing every day but to melt cast-iron and no other metal. Their number is not large, and I do not know whether there are more than one or two in Paris. These founders travel through the country, and make their appearance gradually in different provinces. They make cast-iron weights, plates for different purposes, cast new, and patch old, hollow-ware. These founders buy the pig-iron they want from peddlers, who gather cast-iron scrap in the villages in the vicinity of Paris. This scrap is exchanged for apples; a man with scales in one hand, leading a horse laden with poor fruit, does the business, exchanging apples for iron, weight for weight."

The "Philosophical Transactions" of the Royal Society of London for 1747, reviewing the art of making cast-iron with pit-coal, and casting articles therefrom—something which had been taking place, secretly, at the foundry of Abraham Darby, Colebrookdale, England, from 1713—speaks of it as a curiosity. This enterprising gentleman hailed from Bristol, having leased the iron-works at Colebrookdale in the year 1707, when it consisted of a single small furnace and foundry. Before locating at Colebrook-

dale Mr. Darby had engaged, as an apprentice, a young Welsh shepherd named John Thomas, who accompanied his master and worked in the foundry. The lad observing the ineffectual attempts of a Dutch molder thought he saw the reasons for the man's failure, and was allowed to try his hand, the result being that with the assistance of his master an iron pot was successfully cast. A secret agreement was entered into between the two to keep the secret, which was loyally kept on the part of the boy, who was ever the friend of his master's family when, in after life, they were sorely tried. The great secret of the whole process consisted in effectually leading away the gases generated in the core when the molten iron entered the mold, which, if left confined, must inevitably burst the core and thus spoil the cast. Simple as this may seem at this day, the knowledge of making such casts in iron was so limited at that time that they were enabled to keep their secret for almost a century afterwards.

Abraham Darby died, 1717, when his new enterprise was in a flourishing condition, and was succeeded by his son, who was named after him, and it was through the indefatigable exertions of the latter that coke, instead of charcoal, was finally used in smelting, about the year 1760. Iron-founding received an impetus at this period of its history such as it had never before experienced. The steam-engine of Watt, coming into use at this time, developed the iron manufactures at a wonderful rate, as by its means blast power was increased, and all rude contrivances, as blacksmith's bellows, and rotary machines driven by horses or oxen, which had been employed for creating blast in furnaces, were gradually abandoned in favor of the blowing engines driven by steam.

Castings in iron for the early engines of Watt and Boulton were made at Colebrookdale, as were also those for the first cast-iron bridge, which was erected over the Severn, close to the works, by the third Abraham Darby, and opened for traffic in 1779. To meet the growing demands of this newly awakened industry the Darby firm had soon to open other works at Ketley and Horsehay, and branches of the same firm were established at Liverpool and Bristol; also, agencies for the disposal of machinery, manufactured by this firm for mining purposes, were opened at Truro and Newcastle. The renown of this pioneer foundry has spread throughout the world; their reputation as manufacturers of modern machinery is only equaled by their perhaps greater renown as producers of the highest class art work of every description in cast-iron and

bronze. The days of long ago are still forcibly indicated by relics which are still treasured with the greatest care, although the works, generally, are for the greater part modern in arrangement and equipment. An old furnace may be seen on supporting beams, dated "1658," and three others have "Abraham Darby 1777" inscribed on them. One old foundry has a plate over the door with "1774" on it, and they still retain possession of the old cylinder, 4 inches diameter and about 36 inches stroke, which originally belonged to Trevethick's first locomotive.

We can conceive of the difficulties attending the early efforts of our forefathers in the manipulation of such castings as were needed by the pioneer engineers, whose demand for fine iron castings would steadily increase as the practicability of steam power became manifest. About the year 1769 steam was universally recognized as the chief motive power, and was gradually applied to all descriptions of machinery. No doubt failure often resulted when trials were first made on castings of the nature required. All this new work had to be done by molders, who, necessarily without knowledge of the nature of materials, must grope their way with absolutely nothing but hard and inexorable experience to guide them. Under such adverse circumstances there was no other way to success but hard endeavor; if a casting was bad, it was necessary to try again, and again if need be, hoping to discover the cause of failure and avoid next time the errors of preceding trials arising from ignorance of first principles. It is a lamentable fact that, although a century has since passed, the rank and file of molders are to-day working on the same indefinite lines.

The change from castings of a very ordinary type to the superior kinds required for steam- and blowing-engines, as well as machinery of all descriptions, which at this time was being rapidly changed from wood to iron, must have been almost bewildering, as nearly all parts of the engine, including crank, connecting-rod, and beam, were then made in cast-iron, of elaborate design and intricate in the extreme. Good molders must certainly have been everywhere in great demand, especially such as were able to make castings that must of necessity be made in loam and dry sand. Examples of high-class molding were set in those early days, which, with very few exceptions, have abided with us, unaltered, to this day.

About this time, the old devices for manufacturing woolen and cotton goods were supplanted by Arkwright's "throstle" and

Crompton's spinning mule, which in time were built up almost exclusively of cast-iron. Wooden bridges began to disappear in all directions, and cast-iron structures were erected in their stead. The great Henry Cort, of Gosport, England, invented a method of rolling iron instead of hammering (1783), and from this event a demand for still another class of heavy castings was inaugurated; while later on, about 1807, paddles were introduced for the propulsion of ships, which called for superior castings suitable for marine engines. Subsequently, about 1836, the screw propeller usurped, to some extent, the unwieldy paddle, and, with the advent of this remarkable device, arose the finest example of molding yet seen. That the iron founders of the past were invariably equal to the occasion is eminently proved by the casting of the screw propeller, which to this day is molded after plans discovered by our predecessors during the early days of steamboating. The advent of hydraulic machinery caused a demand for castings of such magnitude as to make the erection of special plants for the production of this class of work an absolute necessity. Improvements in agricultural and textile industries also demanded the erection of massive foundries.

Up to thirty years ago very few of the improved methods of molding now practised had been introduced in the foundries; nor had any one competent foundryman or engineer attempted to supplant the cumbrous and ungainly equipments of the past by the very elegant and efficacious appliances now found in mammoth model foundries. The ponderous and slow wooden cranes have, by a gradual process of evolution, merged into machines of wonderful efficacy, and are now almost automatically controlled. The overhead trolley for conveying molten iron direct from the cupola to every part of the foundry is an improvement on the old system of hand-carrying necessitated by the magnitude of some foundries in which the distance from the cupola to the furthermost parts of the shop is great; and, where such devices cannot be applied conveniently, we see well kept tracks with switches in every available direction, on which handy trucks, specially constructed for this purpose, are used for conveying, with ease and despatch, every material used in foundry operations. For the time-honored wheelbarrows has been substituted the conveyor, which hauls everything to its destination entirely clear of the foundry floor. Where once all the iron and fuel were carried by hand to the cupola scaffold, we have now, in some places at least, elegant provision of either

electric, steam, or hydraulic appliances for performing this work. The old rule-of-thumb methods of charging the cupola have at last given place to the more sensible and economical system of weighing all material in correct proportion. Attention has been given to many minor things also. We have seen even the riddle superseded first by the common upright screen and then by the swinging and sliding machine riddles, and now the revolving screen is to be seen in many foundries. Cleansing mills, provided with an exhauster to carry off the dust, have superseded the primitive method of scrubbing sand off the castings with stone and wire brush. Loam mills of infinite variety and degrees of effectiveness are to be seen, where once the click of the chopper was to be heard. Some of the modes devised for clamping together the flasks, seen now almost everywhere, are ingenious in the extreme, and it is pleasing to observe how common at this time is Nasmyth's great invention, the geared ladle. Once it was thought that hay and straw rope must always be twisted in the primitive fashion ; but this also has yielded to the spirit of invention, and the rope-spinning machine is throwing off bands, well spun and true. Machines too numerous to mention have been invented during the past thirty years, which, without the aid of a costly pattern, will make either spur, bevel, miter, mortice, or worm wheels. The extraordinary progress of the cast-iron pipe industry, with reference to equipment, has been such as to make that branch of molding almost independent of skilled labor. The same may be said of many other classes of work where large quantities of duplicate castings are in demand, such work being now produced in the several molding-machines with a facility and dispatch impossible by the old methods of ramming by hand.

The invention of plaster blocks paved the way for the improved systems of plate molding which immediately succeeded them, introducing the interchangeable modes of flask pairing and the earlier kinds of stripping plates, the latter principle constituting the chief element of success in the modern molding-machine.

One of the greatest aids to modern founding is the system of tests, chemical and physical, to which, in some firms, the pig-iron is subjected before it is charged into the cupola. When eminent chemists inform us that whatever quality of iron the iron-founder demands can be furnished by the furnace manager, it would seem that it only remains for the foundryman to acquire such chemical knowledge as will enable him to know the exact measure of every element needed to produce the desired quality of

iron, and thus, by chemical analysis, determine all his mixtures. Keep's tests are no doubt the most comprehensive of any of the physical tests for this purpose which have yet appeared, as they embrace every element necessary for discovering the nature and quality of cast-iron.

At present we seem to be on the eve of great changes; and it is somewhat difficult and hazardous to predict the channels which future progress in iron-founding will take. Owing to the system of dividing labor, now becoming so prevalent, it is simply impossible for the ordinary workman to master the details of founding; this, coupled with general lack of education, leaves him, in a measure, incompetent to manage even ordinary establishments intelligently; but how utterly incompetent are such men for becoming heads of the magnificently-equipped foundries now being constructed. To operate such establishments it has been thought advisable, by some, to change the order somewhat, and engage the services of an educated engineer, so that the efforts of the foreman molder shall be directed in paths which run in harmony with known physical laws.

When so much has been accomplished by the uneducated founder in the past, what are we entitled to expect in the future from this added intelligence? Time will show. The age is pregnant with ideas. The full blaze of scientific knowledge is lighting up dark and hitherto mysterious nooks in which nature has hidden many precious secrets. To suppose that the useful and noble art of iron-founding will not share in the riches thus lavishly obtained would be to rank it as among the least progressive of the mechanic arts; whereas recent advances show that it is no longer wedded to ancient ideas and methods, but is eager to embrace any and all sound improvement.

The consideration of the possibilities in foundry practice forces itself upon the attention of practical men who now thoroughly understand these possibilities. Indifference is giving way to active research and investigation, with reference to the supply of suitable material and equipment. Schools of technology will yet be brought to see the importance of giving the foundry more substantial recognition. One of the best modern molding machines owes its origin to experiments, conducted by its inventor, in the foundry of the Stevens' Institute,—a fact which might be profitably borne in mind by the faculties of other technical schools, which, as a rule, are woefully deficient in means for teaching the art of founding.

The introduction of some late inventions for melting iron indicates the march of progress in this particular very forcibly. Every effort is now put forth to prevent the immense waste of heat which occurs in ordinary cupola melting, by a disposition of the tuyeres such as will burn the ascending combustible gases without heating the fuel to incandescence, in which instance the developed heat pre-heats the iron and fuel before it reaches the melting zone. What may we not expect in the prevention of heat-waste, when we find that electricity has at last been successfully applied for melting cast-iron? It is claimed for the "Taussig" electric system of melting cast-iron in exhausted chambers that oxidation and creation of air bubbles are avoided, and that the cost for driving the dynamos is 50 per cent. less than would ordinarily be required for melting by the best practice.

The advent of the chemist in the foundry marks a new era in iron founding, and is perhaps the surest indication of a desire for thorough advancement, as, by his aid, the indecision and doubt hitherto existing must ultimately cease. Mixing of different brands of cast-iron, as well as the alloying of cast-iron with other metals, to obtain a higher degree of homogeneity, or any other special quality in the resultant casting, will, under such qualified direction, be more easy of accomplishment.

Given superior direction, we may confidently anticipate the time when, by the united efforts of the scholar and the trained artisan, the art of iron-founding, in neither equipment nor skill, shall be second to any of the iron industries.

THE TRANS-SIBERIAN RAILWAY.

By Frederic Hobart.

THE longest railway in the world would possess a certain interest from its length alone; and when to that are added the facts that it will open up a greater extent of undeveloped country than is included in the entire continent of Europe, and that engineering difficulties of a peculiar kind are to be overcome in its construction, the line is invested with an importance which should make its location and description worth some study. The details given here in relation to the great Trans-Siberian railway are based upon official reports, and the location described is that made after careful preliminary surveys and finally approved by the Russian government. It may be added that the work of construction has been fairly begun, and that the largest ironworks in that country are busy on the material required.

The work of providing a route across Siberia was committed to the charge of the ministry of public communications—at that time under Mr. Possiet—nearly ten years ago. The expense of the construction of a railway over so great a distance appeared to the minister too heavy to be undertaken, and the first plan proposed was for a mixed rail and water-line. In outline, this plan provided for an extension of the Oural railway to the town of Toumen on the Toura, whence boats can pass by the Toura, Tobol, Irtish, and Obi rivers to Tomsk, the chief commercial city of western Siberia; a railway from Tomsk to Irkoutsk, 1130 miles; a water route by the Angara and Lake Baikal to some point on the eastern shore of that lake; another railway of about 750 miles thence to the head of navigation on the Amour; some 1600 miles of boat line on that stream; and finally a railroad from the river south to the port of Vladivostok.

The survey of the line from Tomsk to Irkoutsk was placed under the charge of Colonel N. P. Mejeninov, one of the most eminent of Russian engineers and a man who is accustomed to take clearer and broader views than most of his associates. He saw, and very strongly urged in his report, the uselessness of building over a thousand miles of road which would be practically isolated for two-thirds of the year, and expressed a most decided opinion in favor

of an all-rail line as the only one which would meet the needs of the country.

This report was practically unanswerable in its reasons; but it was laid aside, and no action was taken until 1886, when the czar himself, his attention having been aroused by a report from General Count Ignatieff, then governor of eastern Siberia, called for all the papers bearing upon the subject. Struck by Colonel Mejeninov's report, he adopted his views and personally ordered General Hubenett, who had then recently succeeded Mr. Possiet as minister, to direct the immediate survey and location of a continuous line at least as far as the Amour. Later he went still further and ordered the construction of the entire line from the Oural mountains to the Pacific. The czar's interest in the road has been shown by many orders and decrees, and by the fact that he sent his son, the czarevitch, especially to Vladivostok, to give greater *éclat* to the formal opening of work on the Pacific end of the road.

The final survey and location was begun in earnest in 1888. Colonel Mejeninov was at the head of the work and himself undertook the location of the central section, from Tomsk to Irkoutsk, while Colonel Viazemski took charge of the trans-Baikal section and Major Oursatti of the Pacific end. These were completed in 1891, but the location of the western section to Tomsk was not finished until 1892, and the final work on the survey of the Amour valley line is still incomplete, although enough has been done to determine its general course. And it will be finished during the present summer.

While this work was in progress, the connecting link between the Siberian line and the railway system of European Russia was completed. This alone was a considerable undertaking, the road being 605 miles long. Starting from Samara on the Volga, it runs for 300 miles, to Oufa, across the plains drained by that river and its tributaries. From Oufa to Zlatooust, 200 miles, it passes through the rough and broken country west of the Ourals; east of Zlatooust it crosses the main chain through the Sirostan pass, ending at Chelabinsk, which, though beyond the geographical boundary, is still politically in European Russia. This town, the starting point of the Siberian line, is on the Mias river at the edge of the great steppe which stretches eastward to the water-shed of the Yenesei, and northward to the Arctic sea.

The czar having finally directed in 1891 that an all-rail line should be built, the work was at once begun. A Commission of

Engineers, appointed to examine the surveys, approved the location ; the road was divided into six sections, on each of which a commencement has been made. These sections would be best described in detail, taking each in its order from west to east. It will be of interest to American engineers to know that their practice has been studied by the Russian engineers and largely followed in location. American methods will be used in construction also, but the equipment of the road will be designed to correspond with that generally in use on the Russian railways.

The river crossings will be the most difficult of the engineering works. Siberia is a country of large rivers, and some of them present especial obstacles to bridge-construction. Most of them run from south to north, the result being that the ice breaks up first in their upper waters. Ice-gorges and heavy, long-continued spring floods are the rule, while the great weight and thickness of the ice make necessary the reduction to a minimum of the obstructions to the waterway, so that few piers and long spans will be the rule in these structures. The design of the important bridges is under the charge of Professor N. A. Beleloubskoi, who is regarded as a leader among Russian bridge-engineers. Among the great bridges will be those over the Ishim, 700 feet in length ; the Tobol, 1400 feet ; the Irtish, 2100 feet ; the Obi, 2800 feet ; and the Yenesei, the longest of all, with fourteen spans of 350 feet. All these will be of iron or steel ; but for the smaller streams many bridges will be built of wood, generally of the Howe-truss pattern.

To take up again the sections of the road in their geographical order, the first is the western section, which will be 1080 miles long, from the starting-point at Chelabinsk to the junction with the central section at Pochitanka. For 880 miles the line crosses the great steppe, a high, level plateau, with no marked divides or water-sheds between the rivers. The location here is almost an ideal one ; it follows nearly the 55th parallel of latitude, the only deviations being to secure the best points for crossing the larger rivers, which have generally cut deep channels in the alluvial plain. There are few small water-courses, and the directness of the line may be judged when it is stated that there will be tangents respectively 50, 62, and 86 miles long, and that the road as located is only 2½ per cent. longer than an air-line.

For nearly 600 miles this steppe is an excellent agricultural country, and, though now very thinly inhabited, is well adapted for wheat, rye, and other small grains. The climate, however, is not

an easy one; the summers are warm but short, and the winters severe. At Omsk, a central point, the mean temperature of the six winter months is about 1° F.; the thermometer frequently falls to 40° and even 50° below zero; the snow-fall is heavy, and long-continued northerly winds are common.

For the 300 miles towards the eastern edge of the steppe it is thickly strewn with small lakes, in many of which the water is either salt or alkaline. Much of the land is barren, but much is wooded, and cattle are raised in considerable numbers, thriving on the grass of the salt marshes which abound. For the 200 miles east of the Obi river the road will pass through a more difficult country, hilly, heavily wooded, and intersected by many small rivers. To avoid difficulties in location it was decided to reach the important commercial city of Tomsk by a branch.

The central Siberian line, the second section of the great road, accordingly does not begin at Pochitanka, but 82 miles west of it, at Tomsk, the administrative and commercial capital of central Siberia; this division is 1048 miles long, extending to Irkoutsk, and in one of the more difficult sections of the road. For nearly a quarter of the distance, from Tomsk to Achinsk, it is a line of easy grades, rising gradually through a wide plain intersected everywhere by the upper tributaries of the Obi. While the grading is light, however, this part of the line will be notable for the number of river crossings. No less than forty bridges of over 200 feet in length will be needed, beside a great number of smaller ones.

Just east of Achinsk, and 260 miles from Tomsk, the line enters the Cremia-Ishikin mountains, a series of abrupt, but not very lofty, wooded hills which mark the water-shed between the broad steppes watered by the Obi and its tributaries and the deep valley of the Yenesei. Careful location was needed to avoid heavy work here, and for 115 miles the line will follow a tortuous course to Krasnoiarsk, where it will cross the Yenesei on the great bridge already mentioned. From this point eastward 355 miles to Nijni-Oudinsk there is encountered a succession of rivers flowing through valleys separated by high ridges, and this long section will require many deep cuts and long fills. For 158 miles further, to Oukhtouisk, the general character of the country is the same, but the divides are lower and less difficult. At Oukhtouisk the road enters the valley of the Balaia, and following that river and the Angara has a comparatively level course for the remaining 164 miles to Irkoutsk.

The Angara is a notable stream. The outlet of the "Lake of Death," as it has been called, the great Lake Baikal, is a wide, deep, and rapid river, frozen for two-thirds of the year and in the remaining third subject to quick floods, for which no one has ever been able to assign a cause.

The country along the central Siberian division is not populous. Much of it is heavily wooded on the hills, but low and swampy in the valleys, and not attractive to the settler. The railway follows quite closely the line of the great highway which has been the main line of travel ever since the Russians penetrated the Baikal region. For many years the caravans and freight-sledges from Kiakhta have followed this road, and their business has built up a few small towns; but outside of these there are only some nomad herdsmen in the whole region. There is little doubt, however, that there are coal deposits in the Kainsk foot-hills; iron ore is found and worked in a small way in the charcoal forges at Mariinsk and one or two other places, and it is not improbable that, when the road is in operation, this region may be the seat of an important mineral industry.

At Irkoutsk begins the third section, known as the Baikal loop, which is the shortest but most difficult of the whole line. In the five months when they are free from ice the deep, sullen waters of Lake Baikal are treacherous and unsafe, so subject to disturbance by violent gales that no reliance can be placed on their navigation, and it was apparent that the road must be carried past the lake in some way. Many preliminary lines were run, and it was only after long consideration that Colonel Viazemski finally recommended a location. The division is 194 miles in length, but its cost will be heavy, even with a ruling grade of 2 per cent. and the sharpest curves allowed on the road. From Irkoutsk the line runs southward along the Irkout river, following the many windings of the stream, mainly in side-hill cuttings in heavy clay, for 60 miles; then turns sharply eastward into a pass in the Zirkizoun range, which it will cross through a tunnel 12,500 feet long, at a height of 770 feet above the lake. The eastern slope of the mountain is followed until the line strikes the southern point of Lake Baikal at Koultouk; thence it keeps closely to the shore of the lake to Misovskaia.

No city in the world, probably, has a wider range of temperature than Irkoutsk, where in summer 98° F. is not uncommon, while in winter the thermometer registers from 50° to 65° below zero. The Baikal region is a high plateau, open to the north, remote from the

tempering influences of the sea, and its climate is that which might be expected under these circumstances.

At Misovskaia begins the trans-Baikal section, 663 miles long, which will carry the road into the region whose waters are tributary to the Pacific. Briefly described, this section runs for 60 miles along the shore of the lake and through the valley of the Selenga to the town of Verkhne-Oudinsk, the oldest in the trans Baikal. From this point there is no doubt, although it is not yet located, that a branch will run up the Selenga some 75 miles to Kiakhta, that strange double frontier town where for many years the business between Russia and China has been exchanged, and from which the great sledge trains start yearly on their long, slow journey westward. This traffic will be a considerable item for the railway.

From Verkhne-Oudinsk the main line runs eastward through the valley of the Ouda, rising gradually toward its headwaters, until, about midway in the division, it encounters the barrier of the Jablonnovoi mountains, the highest in eastern Siberia. Here no less than fourteen of the mountain passes were examined before a location was made. The line adopted crosses the foot hills into the upper water-shed of the Lena, then recrosses the main range by the Shoidak pass at a height of 3700 feet above sea level,—the highest point on the road,—and descends through several small river valleys into that of the Shilka, the chief western tributary of the Amour, which it follows to the head of navigation at Sretensk.

On this section materials of construction abound and the work is not heavy, except for a few miles through the Shoidak Pass. The trans-Baikal is the rich mineral section of Siberia. Iron ore abounds in the Jablonnovoi range, and there are gold, silver, and copper deposits which are already worked in a very limited way, but which can be largely developed when the railroad reaches them. The winters there are intensely cold, but the air is dry and the snowfall very light. Agriculture does not exist, but in the wooded valleys large herds of cattle and horses are raised by the nomad Toungoos tribes.

The Amour section, from Sretensk through the valley of the Amour to Grafskaia, is the longest and will probably be the easiest on the line. The distance is 1600 miles, and the line is not yet fully located, but the preliminary surveys show but slight difficulties to be surmounted. The Amour country is justly regarded as the garden of Siberia. The river valleys are fertile and well watered, timber abounds, and the climate is much less severe than

in central and eastern Siberia, tempered by the vicinity of the sea, and in some measure protected by mountain ranges from the Arctic winds. Population alone is needed, and comes but slowly, in spite of the efforts made by the government to encourage free immigration from European Russia. There are few or no convicts in the country, the trans-Baikal having so far been the limit of deportation from the west.

What is known as the Oussouri section is the last in order. It runs from Grafskaia southward through the valley of the Oussouri, a tributary of the Amour, breaks through the hills at its headwaters by a long, deep cutting and two tunnels, 700 and 1100 feet long, into the valley at the southern end of which lies Vladivostok, the Russian port and naval station on the Pacific. This division, though the last named, was the first on which work was actually begun. Formally opened by the czarevitch nearly two years ago, more than half the grading of this section was completed early in the present year, and some 50 miles of track laid. The Oussouri peninsula has valuable deposits of coal, which are already worked to some extent, while other coal fields and deposits of copper, iron, and lead will be reached by a branch line of 200 miles, which has been located to Khabarovka, the capital of the province.

The whole length of the main Siberian line is 4700 miles, and its estimated cost $196,000,000. The line, with branches, will cover 5000 miles to be built by an expenditure of $200,000,000. The present program provides for the completion of the main line to Krasnoiarsk in 1896 and to Irkoutsk in 1899, and of the entire road in 1904, but whether this can be fully carried out is somewhat doubtful. Conceding the financial ability of Russia, the main difficulty will be found in the supply of labor.

It should be mentioned that the estimate given is for a line with steam ferries at the four or five great river crossings, where bridges would add $5,000,000 or more to the estimated cost.

It is reasonably certain that Vladivostok will not be the permanent Pacific terminus. That port is too far north and is not a sufficiently convenient harbor for the purpose. There is no doubt that a secret but careful reconnoissance has been made of the Korean ports, and that one of them will be the terminus as soon as the time is ripe for its acquisition by diplomacy or force. Of course nothing is said about this openly as yet, but the purpose exists and the plan will be carried out in due time.

As to the commercial importance of the Siberian railway there may be different opinions. The steppes of western Siberia are susceptible of settlement and cultivation, and may add a considerable area to the wheat fields which compete with those of America. The river valleys of the Amour region are also capable of cultivation and may in time support a large population, while the Oussouri country is known to be rich in coal and iron. The long stretch of over 1500 miles from Tomsk to the headwaters of the Amour, however, can never have much local traffic. The climate and soil alike forbid settlement, and a small business in horses and cattle from the nomad herds and in lumber from the forests of the Irtish and the western trans-Baikal, with the supply of the mining regions on the slopes of the Jablonnovoi, will be the most that can be expected. Through commercial traffic to the Pacific cannot be large, though the Chinese trade will be an item of considerable importance on the western half of the line, and is a traffic capable of development with the facilities which could be furnished by the proposed railroad. With all allowances for growth, however, it is safe to say that, if the road is regarded simply as an investment for capital, its commercial prospects would not warrant its construction for very many years to come.

The main purpose of the line is not commercial, however, but military and political. The Trans Caspian Railway has consolidated and made permanent the Russian power in Central Asia, and its extension to Khokand and Tashkend, now well under way, will make an excellent supply line for an army invading China from the West. The Siberian line on the other side will be a base line for operations from the North and East, and the ancient empire will be placed at a serious disadvantage. The shrewdest of the Chinese statesmen are aware of this, and their efforts to strengthen their northern frontier are in contrast to the supineness of the English, who seem now, as usual, to rely altogether on their naval force to check the designs of their great rival in the east.

It is undoubtedly a perception of these possibilities which has made the project a favorite one in the Imperial circle, and brought about the conditions necessary to secure its early execution. The official order calls for the completion of the entire road in 1904; and while it seems hardly possible that the work can be completed in ten years with the means at hand, there is little doubt that the opening decade of the twentieth century will see the completion of the first Trans-Asiatic railroad.

ENGLISH AND AMERICAN RAILWAYS.

A COMPARISON AND A CONTRAST.

By William M. Acworth.

THIRD PAPER.

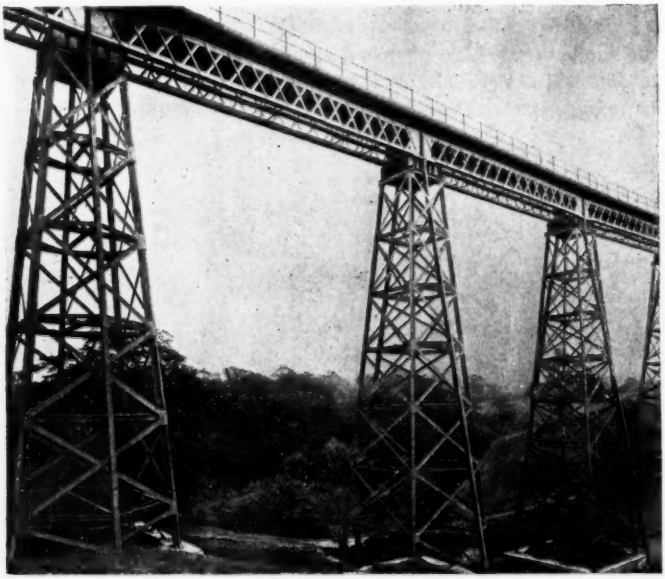
THE preceding papers in this series having contained a summary of what seem to me the most important points of difference between English and American railways, in what follows I propose to illustrate the characteristic practice of our railways by a series of pictures typical as far as may be of their different features. The first and most essential part of a railway is the road itself, so we shall do well to begin with illustrations of bridges and viaducts. Those given hereafter are all on the line of a single company, the Midland, the bulk of them on the line between Liverpool and London, which many American readers will know as the most picturesque, though not the shortest, route between these two cities. They explain themselves, but

MIDLAND RAILWAY—HARRINGTON VIADUCT.
[Eighty-two arches, each 40 feet span.]

MIDLAND RAILWAY— RUGBY VIADUCT.

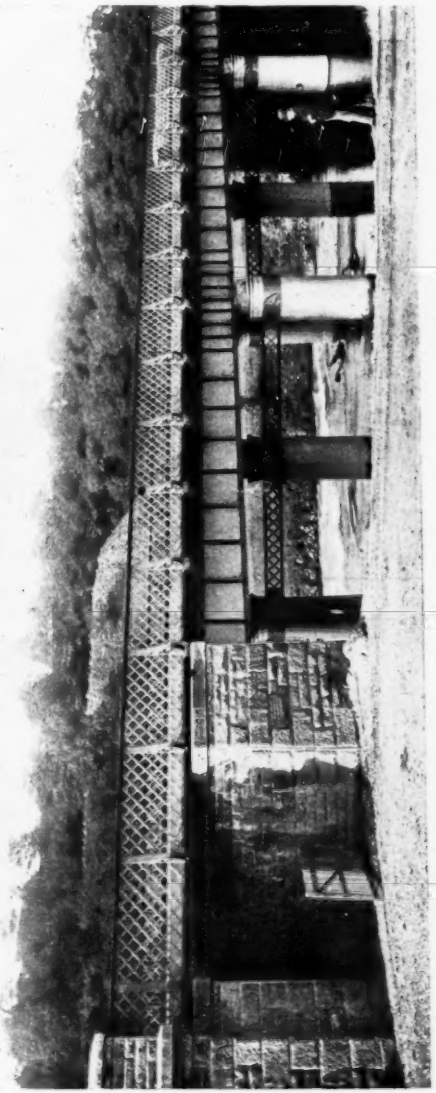
[More than fifty years old.]

perhaps I may add, as showing that English railway-works have been of the most solid possible character from the very outset, that



MIDLAND RAILWAY—DOWERY DELL VIADUCT.

the viaduct over the Avon at Rugby—11 arches of 50 feet span—was opened in 1839, while the Harringworth viaduct—82 arches of 40 feet span—was only built some thirteen years back. The unprecedented incursion of American ideas displayed in the Dowery Dell viaduct on the Halesowen branch may be explained by the fact that the line, though now worked by the Midland, belongs to, and was constructed by, a small and impecunious independent company. The illustration of a Sunday morning's work, relaying the line at Wickwar near Bristol, may serve as a sample of the method in which the permanent way is laid. The picture of the water-troughs on the main line of the Northwestern will



MIDLAND RAILWAY, MANCHESTER TO LONDON—WHATSTANDWELL BRIDGE.

also be useful for this purpose, while not a few of the remaining illustrations will afford incidental glimpses of English railway structures.

Next there is a series of pictures of stations. Broad street, in the heart of the city of London, belongs to the Northwestern. The land on which it stands cost $300,000 an acre, and is probably worth twice that sum to-day. This station deals with a vast miscellaneous traffic in valuable freight; tea and dry-goods, wool and

MIDLAND RAILWAY—RELAYING THE LINE.

silk, are shipped, and fish and meat received, in enormous quantities. A feature of this station is the "Field," now roofed over, but open when my picture was taken two or three years back. In the background goods-wagons are shown while being raised on hydraulic lifts. Liverpool-street station is the terminus of the Great Eastern, which serves the working-class districts of the East end of London, and carries over 80,000,000 passengers per annum. Bishopsgate is a station half a mile further down this

same line. The Waterloo terminus of the London and Southwestern has a suburban traffic as dense, reckoned in number of trains,—about 700 *per diem*,—as Liverpool street. Its passengers are not so numerous, but being of a much higher social class, and consequently traveling largely "first" instead of "third," they require more room per head than the Great Eastern workmen. Waterloo station itself is a ramshackle place enough. Originally built in 1848, it has been patched and added to at frequent intervals ever since. But the brand-new signal-box, which stands astride of the entrance to it, is perhaps, with its 242 levers of the latest design, with its elaborate electric control of every movement, and with its staff of ten men, the most perfect signal installation in the world. As such it well deserves reproduction here.

For illustrations of country stations I have thought it well to go to the Lancashire and Yorkshire, one of the most remarkable lines in the world, though visitors to England are not very likely to come into contact with it. The Lancashire and Yorkshire Company is entirely confined to the two counties whose name it bears, but it serves every part of the densely populated district between Leeds and Liverpool. It has not more than some 520 miles of line, but while only fourteen of those miles are single, between thirty and forty are quadruple, and the rest double. The capital of the company is about $250,000,000; it has over 1000 engines and nearly

LONDON AND NORTHWESTERN—WATER-TROUGHS.

MIDLAND RAILWAY, MANCHESTER TO LONDON—CROMFORD STATION.

4000 passenger-vehicles, while its 520 miles are divided into over 700 block-sections. From this line, whose operating department is a model of excellence, I give illustrations of some typical stations: Daisy Hill, a roadside station between Liverpool and Manchester; Rochdale, an important junction; and lastly Blackpool, probably the greatest excursion center in the world. At certain times of the year the inhabitants of Lancashire cotton towns simply migrate *en masse* to the seaside; and Blackpool thinks it nothing out of the common to receive fifty excursion trains before 11 o'clock in the morning. A picture of the locomotive-works of the

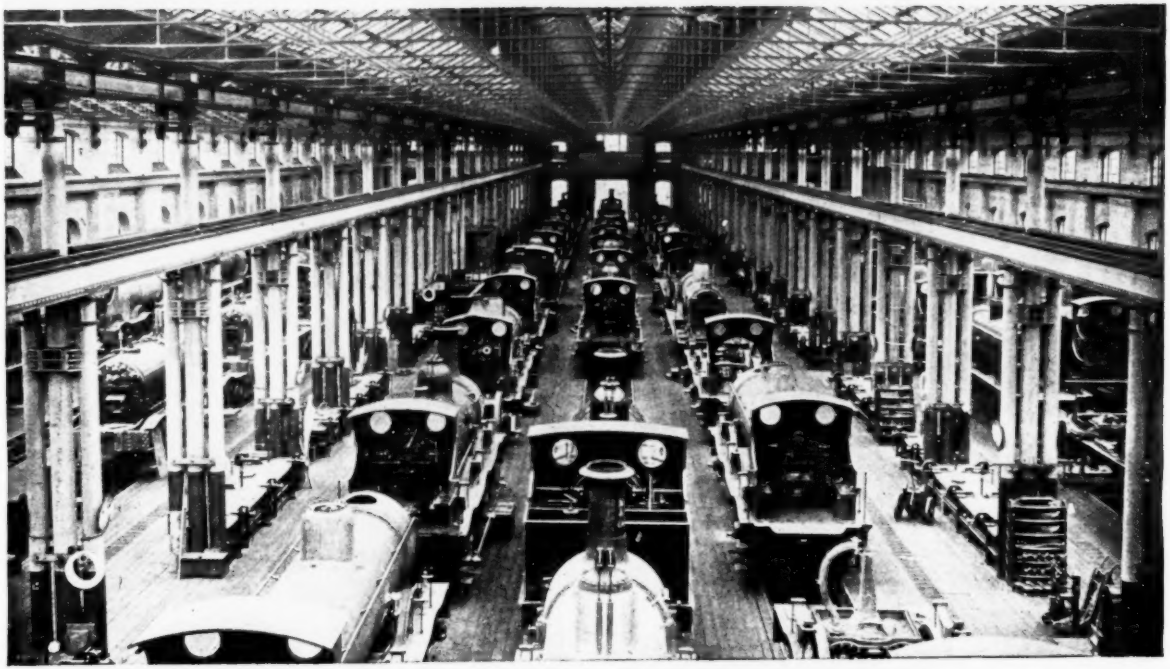
PARKESTON QUAY, NEAR HARWICH.

[Great Eastern railway passenger station and hotel to the left.]

same company, the Midland, at Derby,* will suffice to illustrate another side of English railway construction. Perhaps, too, as most of our great lines have docks and steamships of their own, I ought to add Parkeston quay, near Harwich, the property of the Great Eastern, to illustrate railway buildings of a very different kind.

But it is time to turn from buildings to rolling-stock. English express passenger-engines are of two main types. That which will

* The great English companies all build their own locomotives and carriages, and only have recourse to private firms in time of exceptional pressure.



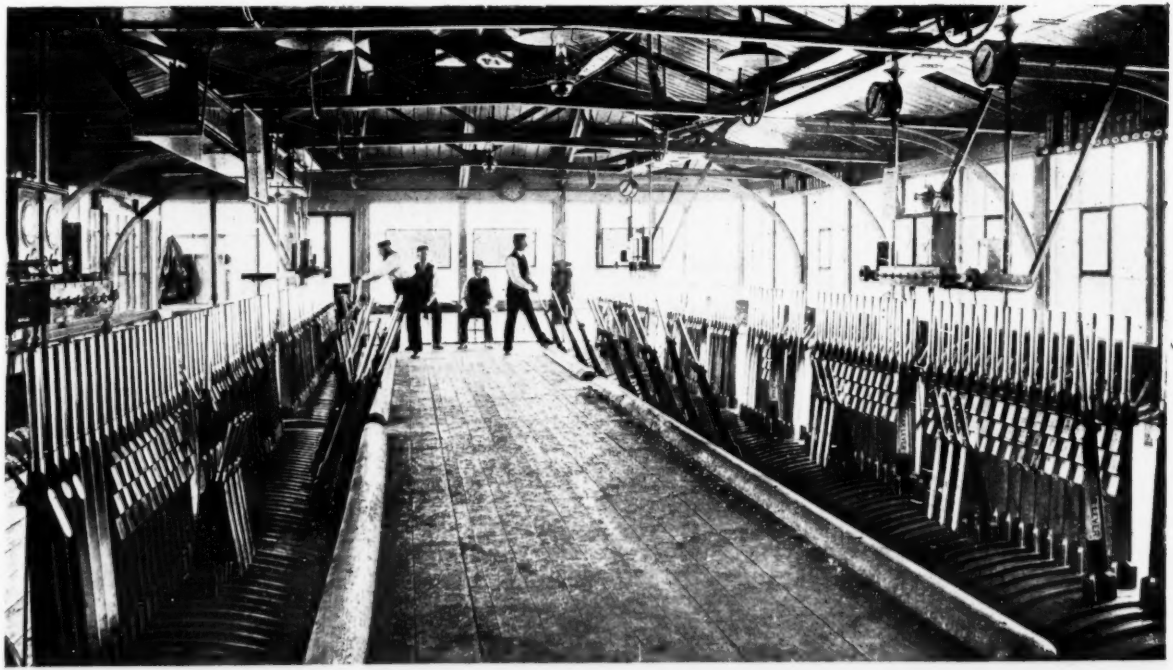
MIDLAND RAILWAY LOCOMOTIVE-WORKS, DERBY—THE NEW ERECTING SHOP.

LANCASHIRE AND YORKSHIRE—DAISY HILL STATION.

be most familiar to readers in the new world is what you would call the "American" type, with four drivers coupled and a swiveling truck (which we call a "bogie") in front. Of this type I give illustrations of a Midland and Caledonian engine, both as used for the fastest and heaviest trains, and a Caledonian engine, somewhat smaller, used for working the expresses between Glasgow and the summer resorts on the Firth of Clyde. The "Greater Britain"

DAISY HILL STATION, FROM WIGAN END.

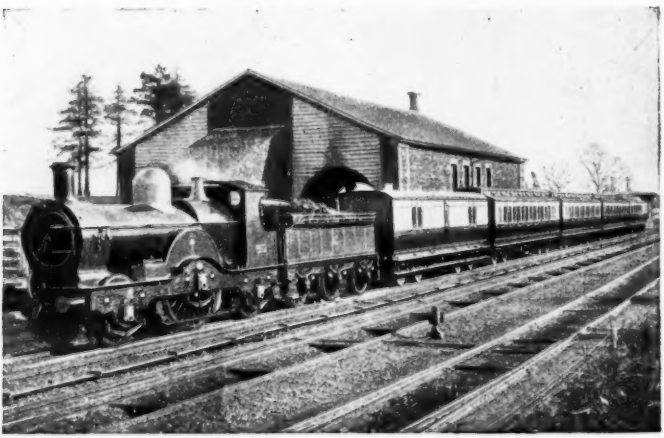
LONDON AND SOUTHWESTERN RAILWAY, "A" BOX, WATERLOO—WROUGHT-IRON SIGNALS.



LONDON AND SOUTHWESTERN, "A" BOX, WATERLOO—242 LEVER-LOCKING APPARATUS.

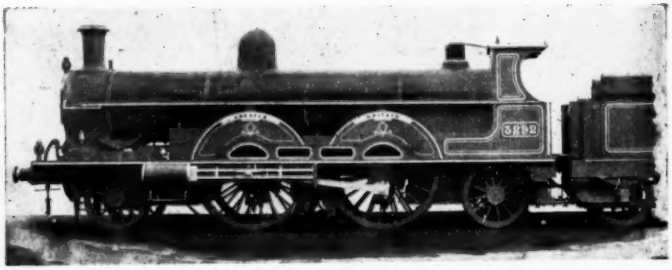
LANCASHIRE AND YORKSHIRE—ROCHDALE STATION.

of the London and Northwestern deserves special notice, though it cannot be said to be typical of normal English practice. This is a three-cylinder compound on Mr. Webb's system, with two high-pressure outside cylinders, 15 inches diameter, driving the trailing-wheels, and one low-pressure cylinder inside under the smoke-box, 30 inches diameter, driving the leading wheels. It will be noticed that this engine has an exceptionally long boiler, and that both pairs of drivers are in front of the fire-box. The boiler-tubes (which in English practice are almost universally copper) are therefore divided into two lengths by a combustion chamber, the back group being 5 feet 10 inches long, while those between the cham-

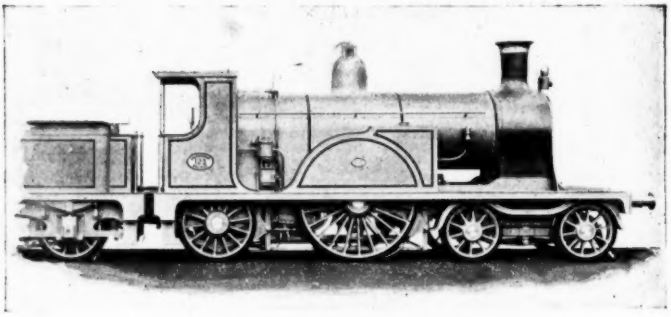


GREAT WESTERN RAILWAY—CORRIDOR TRAIN.

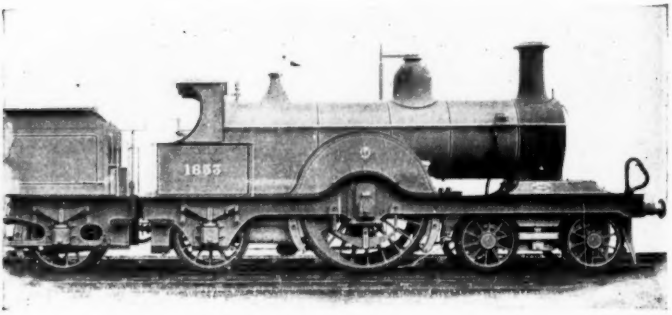
LONDON AND NORTHWESTERN—INTERIOR OF THE QUEEN'S DAY SALOON.



"GREATER BRITAIN" LOCOMOTIVE—3292.

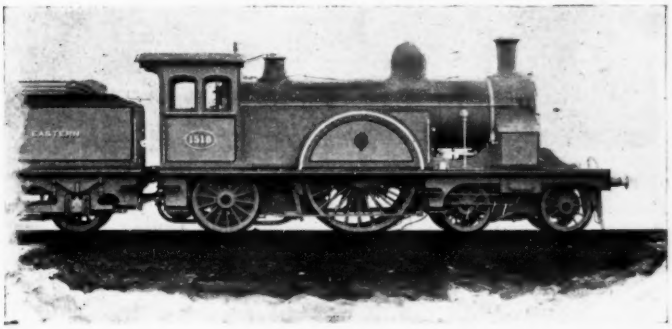


CALEDONIAN RAILWAY—LOCOMOTIVE "123."



MIDLAND RAILWAY—LOCOMOTIVE "1853."

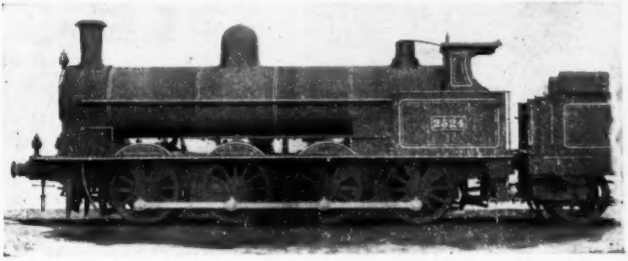
ber and the smoke-box are 10 feet 1 inch in length. The working pressure of steam is 175 pounds, and the total weight of engine and tender in working order 77 tons 2 cwt. I give likewise a picture



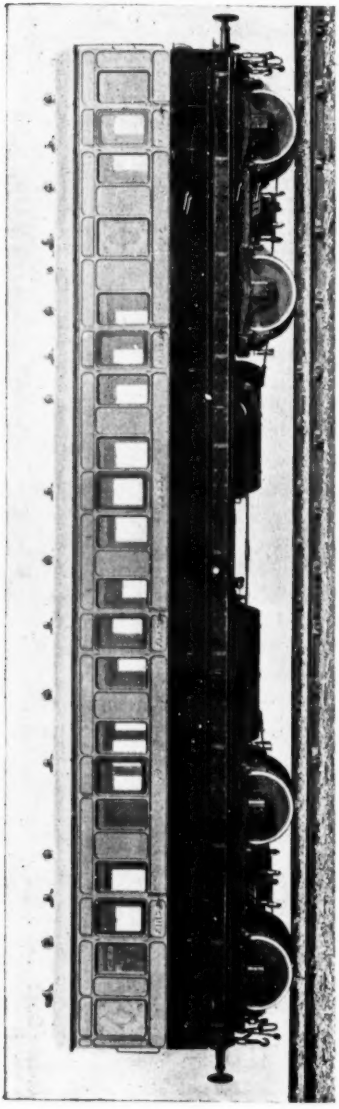
NORTHEASTERN RAILWAY—LOCOMOTIVE 1518.

of a new Northwestern goods-engine. It also has an extra long boiler and a combustion chamber and runs on 8 coupled wheels. The universal English goods-engine is identical with the above in appearance except that it has only six wheels in all, instead of eight.

But the typical English locomotive is the express-engine with single drivers. The famous Great Northern engines, which are now a quarter of a century old, are entitled to lead the way. They will take a train of 120 tons at 60 miles an hour with consumption of less than 23 pounds of coal per mile. In consequence of the unusual height of the cranks they have outside cylinders, while the accepted English practice is to put the cylinders inside. It will be noticed also that they have no steam-driver. An engine nearly twenty years younger than the Great Northern singles, but not less famous, is No. 123 of the Caledonian railway, built, however, not by the company, but by a private firm, Messrs. Neilson & Co.



NORTHWESTERN RAILWAY GOODS-ENGINE.

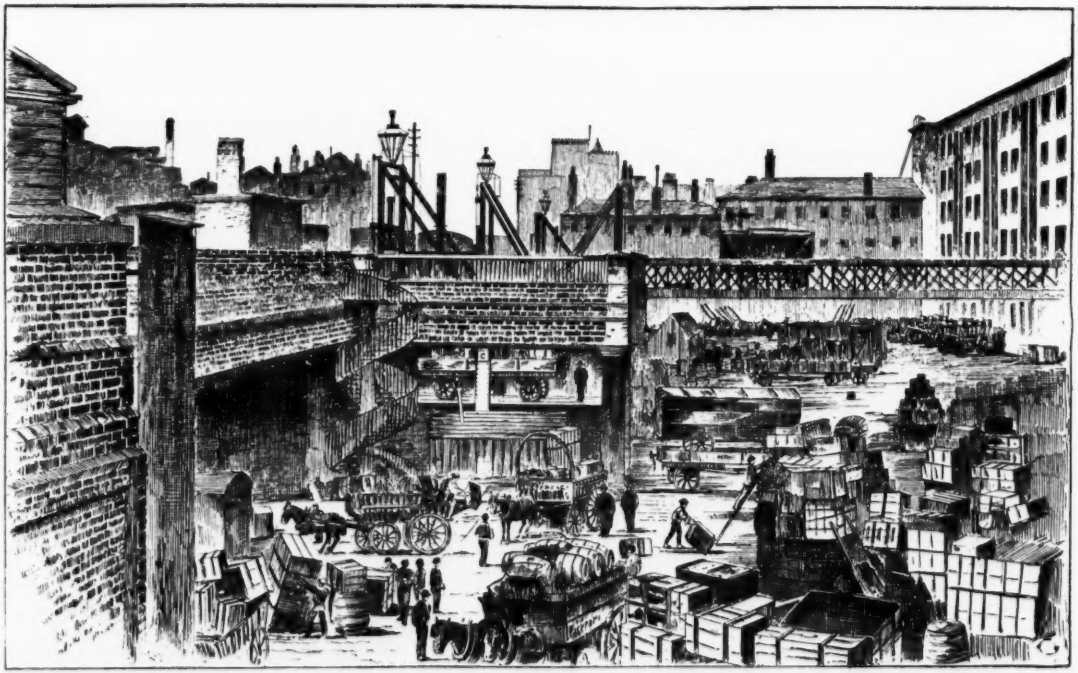


LONDON AND SOUTHWESTERN RAILWAY—"AMERICAN EAGLE" EXPRESS.

This was the engine which, in the "Race to Edinburgh" in the summer of 1888, repeatedly ran the hundred miles from Carlisle to Edinburgh over a very heavy road in from 100 to 104 minutes. No. 1853 is a Midland engine which won a gold medal at the Paris exhibition.

The Midland road is by no means an easy one, yet these engines will take trains weighing 160 and 170 tons at 50 miles an hour booked speed with a consumption of coal seldom rising above 26 or 27 pounds per mile.* And that they do their work with consummate ease I can testify from personal experience. I was on one of them one day with the Nottingham express, timed to run 124 miles in 145 minutes, and we came in 5 minutes in front of time, though for the last 10 miles there had only been enough steam on to lift the weight of the motion off the slide-bars. Lastly let me mention what is probably the biggest engine in Great Britain, the two-cylinder compound (Worsdell and von Borries system) of the Northeastern railway. The cylinders are

* Individual engines have been known to work under an average of 19 pounds for a week.



LONDON AND NORTHWESTERN RAILWAY—BROAD-STREET STATION—THE "FIELD."

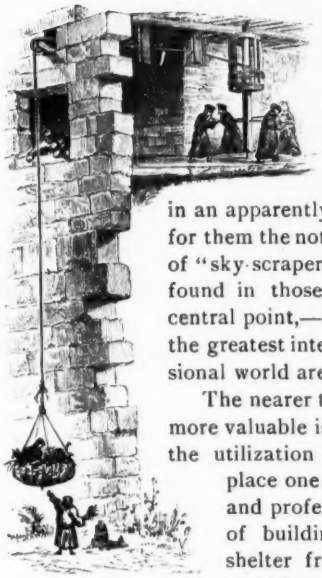
20 and 25 inches x 24-inch stroke, pressure 175 pounds, driving wheels 7 feet 7¼ inches, total weight 86 tons 14 cwt. This engine has taken a train of 270 tons * 67 miles in 78 minutes. It will be noticed that, alone of English engines, it has a "cab" something like an American one. It will be noticed also that all the "single" engines shown, except the Great Northern one, have steam sanding apparatus. Finally it may be said that English tenders have always six wheels and a rigid wheel base.

Lastly we come to carriages; and, as in duty bound, I begin with the Queen's day saloon on the Northwestern railway. This carriage is, it will be seen, small and antiquated; but the Queen has grown accustomed to it and refuses to allow it to be either replaced or modernized. There is a sleeping-saloon of similar size and construction, which usually accompanies it. Her Majesty travels, it will be observed, on six rigid wheels; nor, as English road-beds are kept in first-class order, and the speed of her train is limited to about 35 miles an hour, does she suffer much by doing so. But the rest of her subjects find "bogies" run easier, and eight-wheel stock is becoming the accepted pattern for main-line trains. Of this a West Coast "sleeper," showing that even in our sleep we preserve our insular prejudices in favor of "lonesome, stuffy compartments," furnishes one illustration. On the other hand two pictures of old and new Great Eastern carriages, first-class and third-class respectively, show that for ordinary local travel standards have varied but little in the last quarter of a century. Lastly a series of pictures of two new trains, the "corridor train" on the Great Western, and (which should interest American readers) the "American Eagle express," between London and Southampton, show tentative approximations to the practice of the United States. In the latter train it will be observed that each carriage is disconnected. In the former there is connection throughout the whole length, but the doors between the carriages are locked,—a precaution which it seems impossible to dispense with as long as three different classes of passengers are carried on the train and there are no conductors or car-porters available to exact extra fares from those who change from a lower to a higher class in the course of their journey.

* English tons are always gross tons of 2240 pounds. The American ton of 2000 pounds is entirely unknown here.

THE AMERICAN PASSENGER ELEVATOR.

By Thomas E. Brown, Jr.



THE ORIGINAL PASSENGER ELEVATOR.

[From an old print.]

THE most noticeable feature in the recent growth of the large cities in the United States has been the advent of tall buildings. They occupy oftentimes but a small surface area, but they tower upward in an apparently reckless manner that has gained for them the not altogether incongruous cognomen of "sky-scrapers." Especially are these buildings found in those portions of a city adjacent to a central point,—congested localities around which the greatest interests in the financial and professional world are bound to congregate.

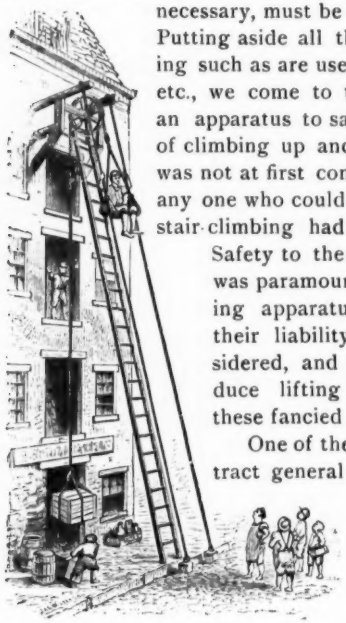
The nearer the approach to the center, so much more valuable is the area or space occupied; hence the utilization of every square foot of land to place one above the other as many business and professional men as the science and art of building construction can conveniently shelter from the weather. Not only is this ambition of the land-owner or capitalist to reach the clouds confined to business quarters, but in the most desirable residence streets people prefer to be removed some distance vertically from terra firma, rather than be at a lateral distance of several miles from the best points for business. The result has been a complete metamorphosis in the character not only of external architecture, but also of interior construction.

Few persons, even in the architectural or constructional professions, have paused to realize fully how entirely this change of conditions is due to the evolution and perfection of the American passenger elevator. It is this perfection of the lifting service, both in regard to speed and safety, that has altered the restful and classic lines of the architecture of a past age,—that pleasing dis-

tribution of mass over a large area,—and in its place substituted a veritable tower treatment of design where the object is greatest economy,—namely, the largest percentage of net return upon the original investment.

As each successive building exceeded its neighbor in altitude by a number of feet, it soon became evident that an economical height had been reached, as the necessary increased thickness of walls and foundations sacrificed more space below than was gained above, to say nothing of the enormous increase in cost. Here the radical departure was made from old-time methods; the walls of a building were no longer required to support the floors, but became merely a shelter from the elements, the steel-ribbed tower interiors being self-supporting, capable of carrying all loads, and also lending their stability to what was required for a suitable outside appearance.

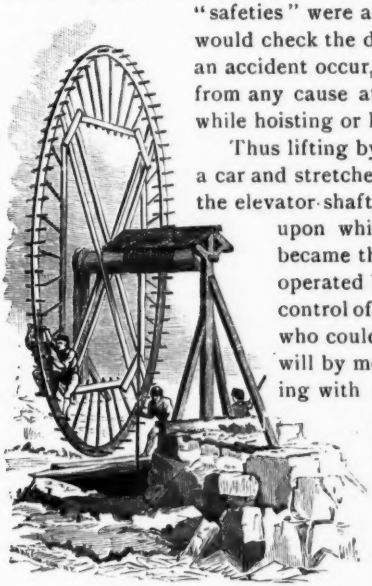
In view of such radical changes, the development of the primary means which rendered these changes effectual, and therefore necessary, must be of considerable general interest. Putting aside all the crude mechanisms for hoisting such as are used in mine-shafts, stone-quarries, etc., we come to the early passenger elevator,—an apparatus to save people the time and fatigue of climbing up and down stairs. Time, however, was not at first considered, it being supposed that any one who could afford to forego the fatigue of stair-climbing had ample time at his disposal. Safety to the person of the vertical traveler was paramount, and therefore ordinary hoisting apparatuses with suspended ropes and their liability to breakage could not be considered, and hence efforts were made to produce lifting machines which should avoid these fancied dangers.



AN EARLY TYPE OF ELEVATOR.

One of the first passenger elevators to attract general attention was one placed in the Fifth Avenue hotel, New York, about thirty years ago. This consisted of a long vertical screw in the elevator-shaft extending through its entire height, and turned by a steam

engine in the cellar, the screw working through a nut attached to the elevator-car, the car and nut being prevented from also turning by guides ; the nut and car were therefore forced upward or let down according to the direction in which the screw was revolved. This machine was slow and inefficient, expensive in operation, and difficult to keep in repair. These defects caused the abandonment of this type of elevator, and inventors reluctantly reverted to the use of ropes and turned their attention to the development of safety devices to prevent accident in the event of their breaking ; these "safeties" were automatic contrivances which would check the descent of the car should such an accident occur, or stop the engine should it from any cause attain an undue speed, either while hoisting or lowering.



A MAN-POWER ELEVATOR.

Thus lifting by ropes attached to the top of a car and stretched over pulleys at the top of the elevator-shaft, thence downward to a drum upon which they wound or unwound, became the next step. This drum was operated by a steam-engine, under the control of the attendant in the elevator, who could start, stop, or reverse it at will by means of a hand-rope connecting with the valve of the engine. A good example of this early steam passenger hoist was in operation as long ago as 1866, in the St. James hotel, New York, where a double-oscillating engine was placed in the bottom of the shaft to operate the winding drum.

The steam passenger elevator came into very general use, and was developed to a high degree of perfection, but these elevators were slow and wasteful of power, and the machinery by its nature produced unpleasant pulsations and vibrations in the car, and, upon the invention of the hydraulic elevator, the steam elevator was rapidly abandoned for passenger service and relegated to factories and warehouses, for the lifting of heavy freight.

One of the earliest forms of hydraulic or water elevator consisted of a sheet-iron bucket attached to the ends of cables which,

THE EIFFEL TOWER.

[Each of the four legs of the tower contains an elevator. These differ from ordinary elevators in that they follow the curve of the tower legs instead of moving vertically. Two of these elevators are of American construction. A fifth elevator, traveling vertically, is used from the intermediate to the top landing.]

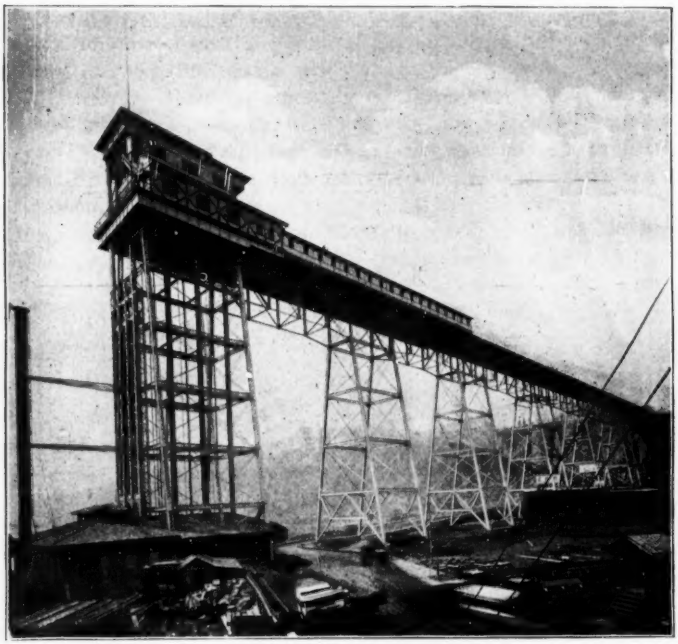
after passing over pulleys at the top of the building, were attached to the elevator-car, the bucket weighing a trifle less than the car. The whole was controlled by powerful brakes acting on the guides or rails upon which the car moved, and a reservoir on top of the building supplied by a steam-pump served as the source of power. When the bucket was empty, the car would descend if the brakes were released, and, when the bucket was filled, the car would ascend. These elevators were capable of very high speed, often attaining a rate of 1800 feet per minute, but, not being subject to automatic control, they were soon abandoned, though one remained in use in

PUBLIC ELEVATOR AT BAHIA, BRAZIL.

[Communicating between the upper and lower towns.]

the Western Union building, in New York, until it was recently destroyed by fire.

In Europe, owing to the prejudice against suspending elevators by cables, which were considered dangerous, and the total lack of faith in safety devices, the direct ram type of elevator came generally into use. In this type the car is placed on top of a plunger working in a cylinder, for which a pit must be excavated in the earth, as deep as the building is high, and, while this type apparently possessed all the elements of safety, its installation required

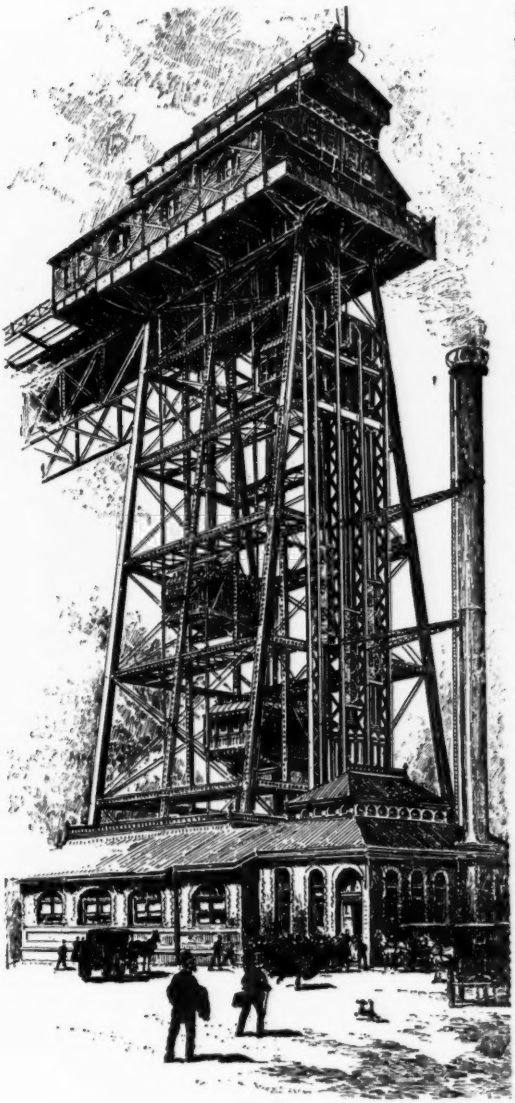


VIADUCT AND ELEVATORS AT WEEHAWKEN, N. J.

[The main tower, in the foreground, contains three hydraulic elevators which are the largest, for passenger service, in the world, and are used to convey passengers from the ground to the railway station above. Each has a capacity for 150 persons and makes the trip of about 150 feet in 40 seconds.

a large outlay entirely disproportionate in many cases to the value of the elevator service. As in this country the height of buildings rapidly increased, keeping pace with the improvements made in elevator appliances, the practical possibilities of the direct ram type were soon outstripped. Few examples can now be found in America, though many are still in use in Europe, where buildings as a rule are not so lofty.

These, however, are rapidly giving way to the American type, large numbers of which are anually shipped to Europe, as well as to other parts of the world, and to-day elevators built by New York makers will be found, not only in the European countries, but also in China, Japan, India, Egypt, New Zealand, South America, and in large numbers in Australia. The introduction of the American type, or suspended lift, in London has already shown



THE WEEHAWKEN ELEVATORS.

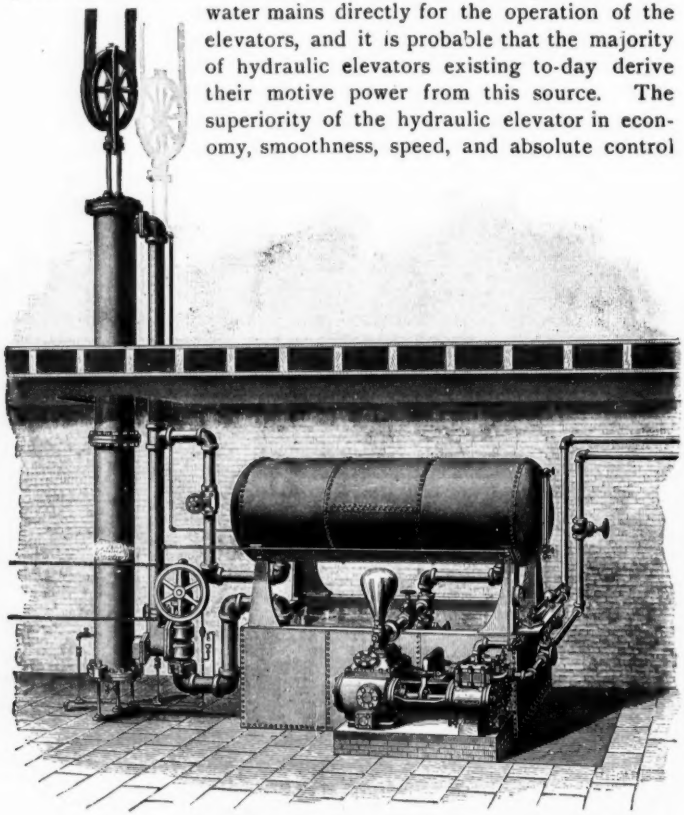
From "Harper's Weekly" by permission; Copyright, 1891, by Harper & Bros.

its effect in the increased height of new buildings designed with reference to its application.

An effort was made some years ago to retain the supposed advantages of the direct ram elevator, and avoid the expense and disadvantages attending the digging of the deep pit. This effort resulted in the production of what was called the telescopic elevator, in which the car was supported on sliding tubes, one fitting in the other similar to the tubes of an ordinary telescope or marine glass. Elevators of this type were used in the New York

Post-office, but, on account of their inefficiency and the difficulty of keeping them water-tight, were soon abandoned.

The hydraulic elevator first came into general use from the fact that most cities possessed waterworks operated under considerable pressure, and it was found practicable to utilize this pressure in the water mains directly for the operation of the elevators, and it is probable that the majority of hydraulic elevators existing to-day derive their motive power from this source. The superiority of the hydraulic elevator in economy, smoothness, speed, and absolute control



HYDRAULIC ELEVATOR CYLINDER, WITH PUMPS AND PRESSURE-TANK IN BASEMENT.

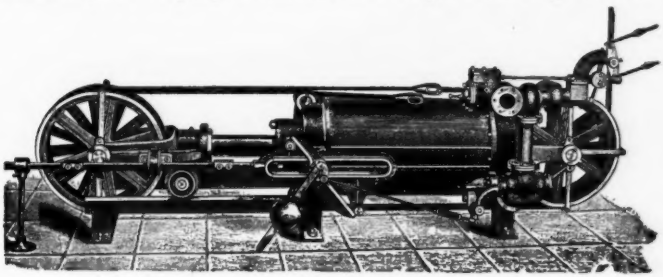
so soon manifested itself that even in cities where water under pressure was not available large pumping-systems were installed in buildings for the sole purpose of operating elevators. Some of these water-power systems in large buildings have a capacity

larger than the water-supply systems of many good-sized towns.

In some cities of England—notably London and Liverpool—waterworks are installed, and many miles of pipes laid in the streets, whose only purpose is the operation of elevators, hydraulic cranes, and similar machinery, and for which service consumers pay at certain rates per gallon of water used, much the same as we in this country pay for gas and electricity. In these systems water is furnished under a pressure of about 700 pounds per square inch.

When the placing of independent pumping-systems for elevators in buildings first came into use, it was usual to place an open reservoir on the roof, the elevators operating under the pressure due to the height of the building; but as the requirements of elevator service became greater, necessitating higher pressures, it was found that but few buildings were of sufficient height to give the pressure required, and hence the system now usually adopted of increasing the pressure due to the height of the building by using closed tanks containing compressed air came into general use; and in cases of low buildings, where the height was not sufficient to give material assistance, such closed tanks were often placed in the basement. The hydraulic elevator of to-day, though made by many different manufacturers, each having a preference for some particular detail of his own, is essentially the same in all cases, superiority of one make over another being simply a question of excellence of design and workmanship.

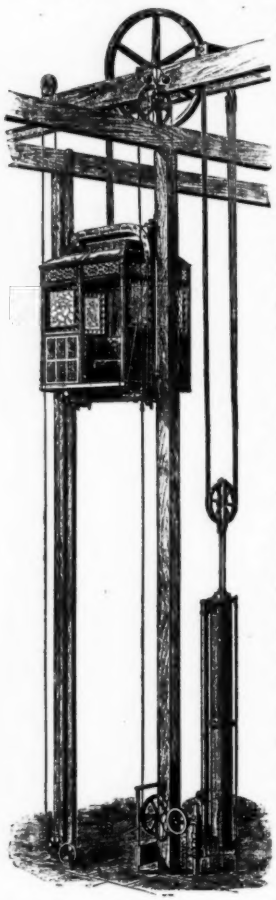
All such machines consist of a hydraulic cylinder, placed either vertically in the elevator shaft, or horizontally upon the floor of the basement, and varying in diameter and length according to the de-



HORIZONTAL HYDRAULIC ELEVATOR CYLINDER.

[Showing multiplying pulleys, controlling valve, and automatic stop.]

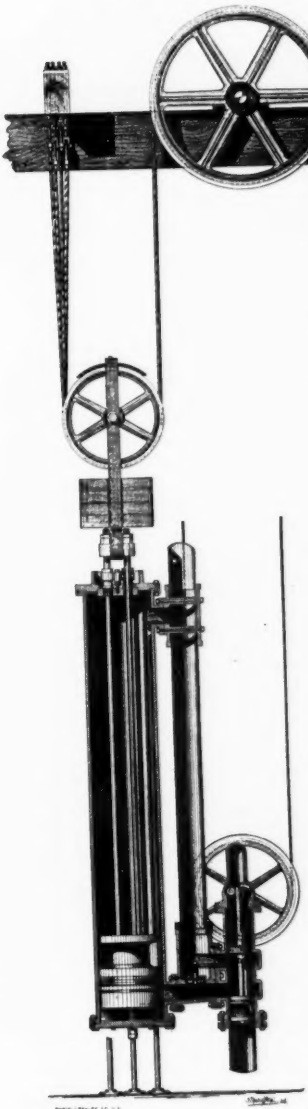
sired power and travel of the elevator. In this cylinder there is a piston with rods attached, these rods passing out of the end of the cylinder through stuffing boxes. The ends of the rods are connected to a pulley or a series of pulleys around which the lifting ropes pass, these ropes being led upward to pulleys at the top of the building, and thence downward to the car. When the cylinder is placed in a vertical position, it is filled with water on both sides of the piston, the upper side of which is acted upon by the water pressure. Due to this power the piston descends through the length of the cylinder drawing in the rods, and therefore pulling upon the ropes, which in turn raise the car.



HYDRAULIC PASSENGER ELEVATOR WITH VERTICAL CYLINDER.

On the principle of the block and tackle, according to the number of pulleys attached to the piston-rods and working in connection with other pulleys in line with the movement of these rods, the movement of the piston through one foot of space actuates the movement of the car through one, two, three, or more feet of space.

The car having arrived at the top of the shaft, and the water below the piston having been forced out, the operating valve is reversed. No longer is the pressure permitted to act upon the piston, but the weight of the car or descending load tends to make the piston travel back to its original position, and in so doing the water is forced out of the top of the cylinder into the lower end, filling the space previously occupied by the former discharge. Thus the elevator in its descent performs its own work through gravity, and simply circulates the water from the top of the piston to the bottom of same, perfect control of the descending load being possible by the government of the



SECTION OF VERTICAL HYDRAULIC ELEVATOR CYLINDER.

rapidity of this circulation. When the cylinder is placed horizontally, one end is usually open to the air, and the travel of the car is regulated by the rapidity of influx of the water to or outflow from the pressure side of the piston. The reader can readily imagine how many devices are possible, all of which would incorporate the principles of operation, as described.

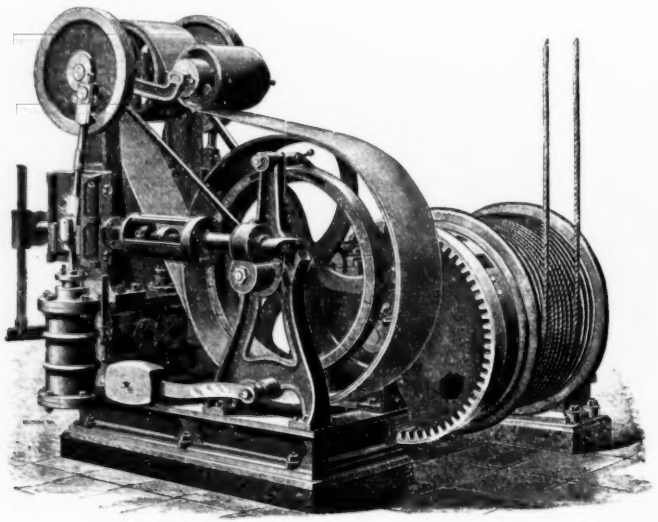
The vertical cylinder was the invention of Mr. Cyrus W. Baldwin, and the elevator first constructed under his patent was known as the Hale elevator. Subsequently, and for many years, the right to use this system was owned by Otis Brothers & Co., but at the present time effective patents cover minor details only.

The practical use of electricity has become so extensive of late years, nearly all towns of any magnitude being provided with installations for both lighting and power with supply mains distributed over large districts, that inventors have turned their attention to the application of electricity to elevators.

Many electric elevators are now in successful operation, and, though it is not probable that electric power will be generated in a building especially to propel

the elevators, at the same time where, by simply tapping electric mains in the street, power may be obtained, the electric elevator is destined to come into very general use. It is true that up to the present time no such elevators have been produced equaling in capacity, speed, and control the great hydraulic elevator systems in use in the large office structures of New York and Chicago, but from the progress already made it is possible that electric elevators will in the near future rival these splendid examples.

Naturally the designers of electric elevators followed closely the lines of construction already developed in steam and hydraulic



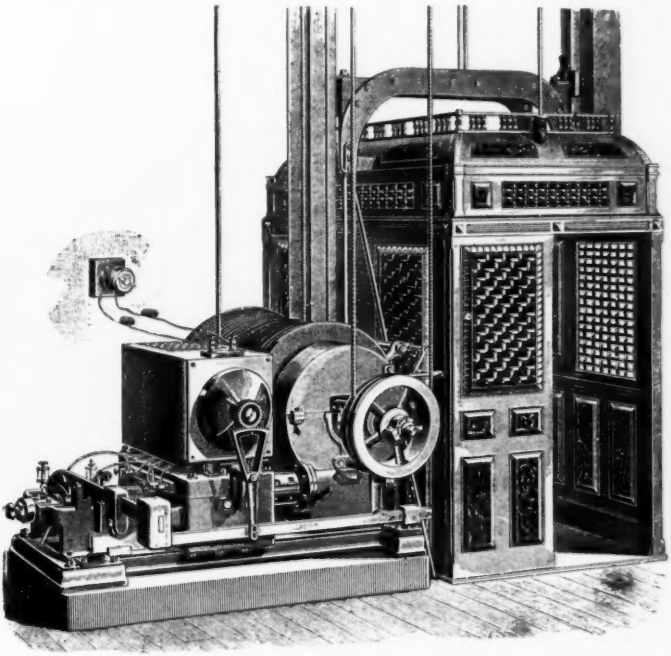
STEAM ELEVATOR ENGINE AND WINDING DRUM.

elevators, and as a consequence two general types exist. The first, and the one by far the most generally used, is similar to the steam passenger elevator, in which the cables are wound on a drum revolved by a worm and gear, the worm being revolved by an electric motor, the motor thus simply taking the place of the steam-engine.

In the second type the principle of the tackle, so generally applied to hydraulic elevators, is used, the fixed and traveling pulleys being made to approach or separate by a long screw car-

rying a nut to which the traveling pulleys are attached, the long screw being revolved by an electric motor. This latter type is somewhat experimental, there being at present but few examples in practical operation.

An elevator-car bears about the same relation to the motive machine, which is the soul of the elevator, that a railway car bears to the locomotive that draws it. The traveling public see the locomotive, but few question or investigate, and of the millions



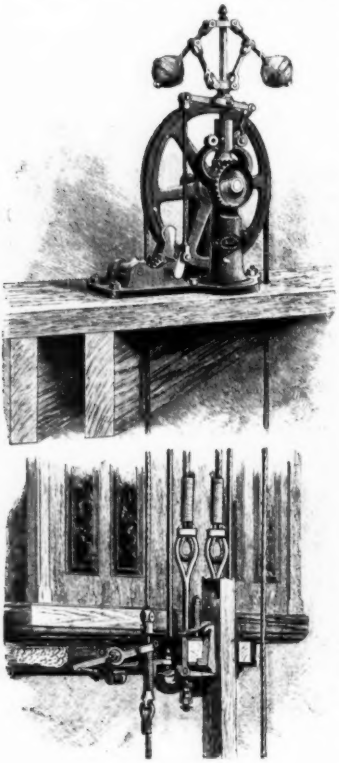
AN ELECTRIC ELEVATOR.

carried in elevator cars daily how few have ever seen the propelling machine, or given a thought to its principles and construction.

Travel in elevators seemed dangerous at first, and naturally so, since the disastrous result of a car falling was clearly apparent. But in fact serious accidents are so carefully guarded against by good construction and efficient safety devices that fewer persons are injured in elevators than in any other mode of travel, and a ma-

jority of the few who are killed or injured meet accident by falling down the shaft through doors carelessly left open or in attempting to enter or leave the car while it is in motion,—mishaps not directly attributable to the elevator.

The accidents to which elevators would naturally be subjected and to prevent which safety devices are provided are: falling, through breakage of the ropes or other parts of the apparatus, overrunning the proper travel either at top or bottom, or loss of control by the attendant. Falling of an elevator-car is a rare and almost unknown accident, and, though frequently we read in the newspapers of falling elevator-cars, such accidents usually prove to be on investigation simply cases of loss of control, or, in other words, "runaways."



SAFETY GOVERNOR.
[Showing attachment to wedge safety-device under bottom of car.]

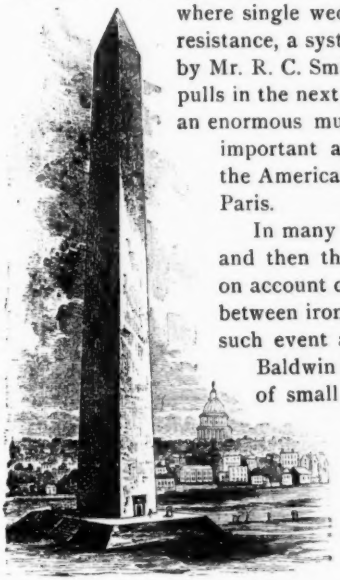
The makers of the better class of elevators allow a large margin of strength, and duplicate the parts liable to breakage. They use at least two, and generally four, and often six or eight cables, any one of which is capable of supporting the whole load, and some makers so arrange the cables that the breakage, or even abnormal stretching, of one or two of them will operate the safety devices and so prevent the use of the elevator until the defect has been remedied.

Under such conditions it is readily seen that the fall of an elevator car, through breakage of the cables, is almost an impossibility; in fact, the writer has never known a case of a first-class

modern passenger elevator falling from this cause. Notwithstanding these precautions in construction, devices are attached to automatically stop and hold the car in the event of a complete breakdown.

One of the oldest, simplest, and best-known safety devices consisted of toothed racks, usually of cast-iron, running the whole height of the shaft, into which strong steel bolts, called dogs, were shot by springs automatically liberated on the car when the cables should break, the springs being held in compression by the tension of the ropes. These "safeties," while very efficient, and answering well at slow speeds, produced too great a shock when operated at high speeds, and hence, as high speeds became a necessity, they were abandoned for safeties producing a more gradual stop.

To-day the device in most general use consists of wedges which, when automatically liberated, compress the vertical guide-strips, usually of hard wood, on which the car runs, until sufficient friction is produced to stop and hold the car and load. In some cases, where single wedges will not produce sufficient resistance, a system or train of wedges invented by Mr. R. C. Smith is used, in which one wedge pulls in the next succeeding one, thus producing an enormous multiplication of power. The most important application of this safety was on the American elevator at the Eiffel Tower in Paris.



WASHINGTON MONUMENT.

Contains a steam passenger elevator having a vertical travel of 500 feet—the highest rise of any passenger elevator in the world.

In many cases iron guide-rails are used, and then the simple wedge is impracticable on account of the low coefficient of friction between iron and iron when lubricated. In such event a safety designed by Mr. C. W. Baldwin is generally adopted, consisting of small hard steel rollers with file teeth, which, when in operation, are automatically jammed against the iron guiding surface. To guard against disaster through loss of control or runaways, caused by derangement of the machinery or carelessness, a speed governor similar to those used on steam-engines is em-

ployed to liberate the safeties and throw them into action when from any cause the car attains in descending an undue speed. Sometimes the governor is placed at the top of the shaft and connects with the safeties by a wire rope, which serves also to transmit the motion of the car to the gyrating balls, and sometimes it is placed on the car itself; in either case its functions are the same.

To prevent overrunning, special mechanism is used, which consists simply of automatic devices for shutting off the steam, water, or electricity, when the elevator reaches the end of its run, and, in the case of steam or electric machines provided with friction brakes, these devices cause the brakes to be automatically applied.

The hydraulic machine is intrinsically safer against overrunning than any other type, for, when the piston reaches the end of the stroke and butts against the end of the cylinder further motion of the car must necessarily cease.

Elevators, like all other machines, however safe they may be when new, can only remain safe when properly cared for and kept in order. So many cases were found where no care was given by those placed in charge by owners, other than such as was absolutely necessary to keep the car running, that Otis Brothers & Co. about eight years ago organized a bureau of inspection, which for a small annual sum periodically examined and reported to the owner the actual condition of the elevator, with recommendations as to what was required for safety. The success of this system was so marked that all the principal elevator-builders rapidly followed suit, and established similar inspection bureaus.

The various accident insurance companies soon saw the opportunities offered by this field, and now these companies, for an annual premium, not only regularly inspect elevators, but also insure their owners against damage for accidents, and defend any suits for damages which may be brought against the insured. It is needless to say that the recommendations of the inspectors for the insurance companies receive prompt attention, as otherwise the policies would become void.

With how much more confidence the elevator passenger rides when he sees posted in a conspicuous place in the car the legend: "This elevator is insured and regularly inspected by the Blank Insurance Co." Were such a legend absent he might even reluctantly mount the staircase, which still is to be found in most office buildings, though rarely if ever used.

PROGRESS IN STEAM-ENGINEERING.

By Robert H. Thurston, LL. D.,

Director of Sibley College, Cornell University.

II.—PROBABLE FUTURE DEVELOPMENT.

AS we have seen in the preceding paper, the improvement of the steam-engine has been effected by the gradual improvement of the machine in its thermodynamic character, as an ideal heat-engine, and the simultaneous reduction of those wastes which are characteristic of the real engine and which represent those imperfections of material and of construction which it is hoped that new inventions and new methods of operation will make, ultimately, comparatively unimportant; reducing the real and the ideal machines to substantial identity. Hitherto this movement has been made, both as respects the improvement of the working conditions of the "working fluid" and the improvement of the machine in which it does its work, without change in the nature of that fluid, or the substitution of other substances for steam; which substance has hitherto done substantially all of the work of the world, so far as performed by heat-engines. Whether combustible gases, the liquid fuels, or other substances will ever, in the course of this improvement of the working fluid, replace steam, is uncertain; but some recent authorities are inclined to expect this finally. There seems no reason to suppose, however, that superheated steam may not, in the end, do all that is expected to be done by the highly-heated products of combustion of such other fuels acting as working substances. For the time, at least, we see no other way of improving our utilization of heat-energy than by the two main processes of further refinement of the steam-engine described in the previous article,—increasing thermodynamic efficiency of the ideal engine and decreasing the extra-thermodynamic wastes of the real machine.

The reduction of the various wastes of the engine—both ideal and real—has been effected by the enhanced thermodynamic action, which leaves a smaller proportion of the heat supplied to be rejected as the so-called—and to some extent inevitable—thermodynamic wastes; by the more careful covering of the heated parts of the machine to prevent heat from escaping by conduction and

radiation to surrounding objects; by reduction of dynamic losses through friction; and especially by the various expedients which conspire to lessen that most remarkable of all these wastes, the internal losses by conduction to and from the metallic walls of the cylinder, resulting in what is technically termed "cylinder condensation," "extra-thermodynamic condensation;" due to "non-adiabatic expansion." In the old engines of Savery, two hundred years ago, the steam entering the machine was mainly condensed by contact with the wet and cold interior of the "forcing vessel," and by contact with the mass of water which it was compelled to force out by direct pressure; the consequence being that where one pound of steam was employed for useful work, about thirty were wasted by this "cylinder-condensation," as it has come to be called, in even the best of these machines.*

The modern type of engine, as first used by patrons of Newcomen, a little later than the time of Savery, utilized about one pound where it wasted by condensation in its working cylinder nearly twenty pounds of steam, by the same process of heat-absorption by the metal of the cylinder, and by the cold water besprinkling its surfaces; notwithstanding the enormous gain effected by the separation of steam cylinder and pump, an improvement even more striking than that made by Watt in separating the cylinder and the condenser. James Watt reduced this waste about one-half by his earlier improvements, and to about seven or eight to one before his death. In the latest forms of engine, by the use of better methods of drying steam, by more rapid motion of the engine, giving less time for this waste, and especially by compounding the engine, in such manner that the wastes of one cylinder are comparatively small, and are nearly identical in amount and in effect in reduction of the same charge of steam in each, one cylinder practically measuring the waste of the combination, this loss has now come to be small; and in the best engines may be as little as 20 or 25 per cent. of the total quantity of steam supplied. Taking pumping-engines as the best gage of progress, the improvement of the machine to date may be fairly taken as below:†

"DUTY" OF STEAM-ENGINES.

A. D. 1700, Savery	5 millions.
A. D. 1770, Newcomen	12 millions.

* "History of the Steam Engine," p. 45.

† "Manual of the Steam-Engine," Vol. I., p. 32.

A. D. 1780, Watt..... 27 millions.
A. D. 1830, Cornish..... .... 87 millions.
A. D. 1890, Multiple-cylinder ....120 millions.

This "duty," as here taken, measures the useful work, in foot-pounds, performed by 100 pounds of fuel. Were there absolutely no engine-wastes, the figure would become about 200 millions, the loss being, still from this internal thermal waste, mainly, about forty per cent. in the better class of modern engines; although one or two cases are now reported in which the wastes are reduced to below thirty per cent., external and internal. Dividing 200,000,000 by the "duty" will give, roughly, the consumption of fuel in pounds per horse-power per hour; and it is seen that the gain since the days of Newcomen and of Watt has been the difference between about 16 pounds and $1\frac{3}{4}$ pounds. The best modern figures are not absolutely established, but are probably not far from $1\frac{1}{4}$ pounds,—certainly not above $1\frac{1}{2}$ pounds. Newcomen and Watt worked with steam at about atmospheric pressure, in single cylinders; while modern engineers, making such records as the last, employ several atmospheres of pressure with multiple cylinder engines, usually "triple-expansion," with careful provision for, as Watt said, "keeping the cylinder as hot as the steam entering it," and, at the same time, making that steam so dry, the engine-speed so high, and the action of the jacket so effective, that substantially all steam received into the engine does some, if not its full, share of the work.

Increased speed of piston and of rotation is easily seen to be an element of this gain. Watt adopted a speed of piston of 128 times the cube root of length of stroke, or from 128 feet, 64 revolutions, in a small engine of one-foot stroke of piston, to 256 feet, 16 revolutions a minute, in engines of large size and of eight-feet stroke. To-day, the so-called "high-speed engine" for electric lighting purposes, and the locomotive hauling fast passenger trains, and the more recent and powerful of marine engines, all come up to at least 600 times the cube root of stroke, and make from 300 revolutions in the small sizes down to nearly 100, with marine engines of five- and six-feet stroke, and of 10,000 horse-power and upward.

Thus, while the refinements introduced by inventors, from Newcomen and Watt to Sickles, Corliss, and Green, have reduced the *thermodynamic* demand of the engine, exclusive of wastes of other kinds, from a theoretical fifty pounds of steam per horse-power per hour to about eight, or of fuel from about four pounds to about

three-quarters of a pound, they have also reduced the thermal wastes of the engine from something like ten times these figures to hardly more than an added fifty per cent. But 50 per cent., still to be gained, represents an enormous value when computed on 50,000,000 of horse-power ; and the average engine offers opportunity to double and treble this profit by reduction of these wastes to insignificance. It may be probably safely estimated that the wastes of the steam power of the world, through the operation of causes more or less capable of amelioration by the ingenuity of man, would still amount to pretty nearly 300 million tons of coal every year, assuming all this immense power to be in constant operation ten hours a day. This is more than the total production of coal in the world at present, probably, but not more than will be necessary, if this waste is not checked at a very early date. Probably the steam-engines of the world, as an average, are not in operation half the time assumed, and, in a large proportion of cases, not even then at full power. The locomotive works, as a rule, but a few hours each day ; the marine engine works a few days continuously and then stops for days or weeks ; and even the regular operation of the engine of the cotton-mill and of the workshop is interrupted one day each week, and sometimes for days together, for repairs ; so that both consumption and wastes of fuel are much less throughout the world than would be indicated by the statistics of steam-power. Perhaps one-fourth the above figure might be taken as fairly representative of the opportunity for gain remaining in visible directions.

The friction of the engine has never yet been given that attention which it demands as an element in the improvement of the economy of the machine. Amounting, as it still does, usually to 5 per cent. in non-condensing, and to 10 per cent. in condensing engines, as compared with the whole indicated power, it is a very heavy tax on the machine and its proprietor. So far as can be now seen, the only ways to reduce this from the actual to the possible, from the above proportion to perhaps a small fraction of those figures, are to make the contact of rubbing parts as light as possible, their movement as small as practicable, and the friction-coefficient as minute as possible ; in other words, to make the now large and excessive work of friction the lowest quantity yet known in the best practice, in every direction. Piston and stuffing-box friction, now usually large, can be reduced by making such constructions as will insure steam-tight fits without pressure, as is ap-

proximately done, in a few instances, by metallic packings for the latter, and by special constructions of ring for the former; valve-friction is reduced to insignificance by balancing; and the other large item, journal friction, may be made a fraction of its customary amount by flooding the bearings with oil, making suitable provision for its continuous circulation, with thorough filtering. It would seem remarkable if this waste of 10 per cent. or more of the expense of operation of steam engines could not be reduced to one-half or even to one-fourth its present amount by the intelligent application of well-known facts and principles.* If, by the progress of improvements, thus seen to have been inaugurated by Newcomen and Watt, one and two centuries ago, the recognized extra-thermodynamic wastes of the steam-engine may be made unimportant, we may hope to see the time when about ten pounds of steam and one pound of good fuel will be looked upon as the goal to be fairly, reasonably, and confidently aimed at by the designer and the builder of the steam-engine of the early future.

For some purposes, as in naval engineering, whether for the navy or the merchant marine, concentration and lightness of machinery are no less important than economy in operation; while for aeronautical applications, now coming to have recognized importance in military operations and possibly for limited use in civil life, this is the prime essential. Progress in this direction is best gaged by the weight of the machine, which has been brought down from about one ton in the earlier part, to 500 or 600 pounds per horse-power in the middle of the century, and to 200 pounds and less in contemporary marine practice; while, in special cases, as in torpedo-boats and fast yachts, the figure has been reduced to less than 100, and even in a few instances to not far from fifty. Mr. Maxim has succeeded, by the use of tool-steel and specially arranged parts, and by the application of extraordinary ingenuity, in making an engine costing a dollar per ounce or more, but only weighing about six pounds per horse-power, as estimated. Even better work is said to have been done by Langley, and still lower figures are promised by other ingenious mechanics. The best work reported to date in aerial navigation has been that of French experimenters, who have driven their spindle-shaped balloons at the speed of a slow railway train by the use of electrical energy from storage batteries; but the "aviators," as the believers in the

* "Manual of the Steam-Engine," Chapter V., articles 132-136; "Friction and Lost Work in Machinery and Millwork," Chapter VII., articles 143-145.

more familiar methods of the birds are called, insist that they will yet make steam do this work far more satisfactorily, and make a speed of fifty miles an hour their lowest limit. The discoveries of the astronomer Langley, showing that it is probable that a high speed will be found at which it will be easier to propel the machine than at any other, either higher or lower, lends confidence to the never-discouraged inventor. On the other hand, the believers in the employment of electric energy, as the means of most effective concentration of powers, are proposing to extend their conquests even to the capture of the transcontinental lines of railway, and expect to connect the great cities by lines of rail, on which they will drive their projectile-like trains at a speed of one hundred miles an hour and upward. That this is practicable as a mere matter of engineering and construction seems probable enough; that it will prove commercially practicable is the really doubtful question. In any case, steam stands behind the scenes and must serve as the prime motor for the whole system, and electricity takes its part by introducing an extensible arm between the mist giant and his work. The giant himself is, at least at present, too ponderous to be profitably carried as a passenger on his own trains.

The problems remaining to be solved are such as these: securing fuel of minimum volume and weight with maximum heat-producing power; making boilers safe for still higher pressures; extending still more widely the range of thermodynamic transformation of the thermal into dynamic energy; reducing still further, and greatly, the wastes of the engine, especially its internal heat-wastes; and concentrating the mighty power of steam into even less compass and weight. Liquid fuels give about twice as much power as the coals, per pound and per cubic foot; boilers composed of many small chambers give greater safety, both from explosion and in case of explosion at high pressure; increased pressures, with further multiplication of engine-cylinders, promise further economy, and superheating the steam, should this ever be found permanently and safely practicable, gives perhaps even greater promise in this direction; the better kinds of iron and especially of construction-steels, the new alloys constantly coming into sight, and the more skilful use of materials by the designer, are conspiring to give further concentration of power, both in weight and space; and there seems to be no reason to doubt that the immediate future holds out promise of continued, perhaps of still

accelerated, advances in all these directions, and of as many astonishing changes in the coming generation as have distinguished that just passed.

For the moment, at least, the advances of the century have brought us to the construction of steam-engines light enough to compete successfully with the motive organs of the birds; others economical enough to give us a horse-power for an hour with every twenty ounces of fuel burned in their boilers, and to carry a ton a mile, at sea, on the expenditure of a half ounce of coal; quick enough in their rotation to accompany the spinning armature of the dynamo-electric machine and to drive their dispersing energy over miles of wire, to give light or power to distant buildings or to cars loaded with a hundred passengers. The culmination of human ingenuity and skill seems to be presented in the new ocean steamers, weighing ten to twelve thousand tons, driven across the seas at the speed of twenty-five or more miles an hour, by the power of 20,000 to 30,000 horse-power; converting into that power the latent energies of the comparatively small quantity of coal that can be carried in their holds, beside their immense loads of cargo, and while transporting a thousand passengers with their almost as numerous attendants.

Should this progress culminate in the discovery of methods of direct conversion of the energy of chemical forces into mechanical power without those enormous thermodynamic losses now apparently absolutely inevitable between our coal beds and our various machinery, our own times will very probably stand to those of future ages as, in respect to intellectual development, the days of the ancient Greeks stand to later times.

FIRE RISKS IN ELECTRIC INSULATION.

By Frederic A. C. Perrine, D. Sc.

IN the early days of electric-lighting—and not more than ten years ago at that—the writer was sent, together with other workmen, into the cellar of the laboratory connected with a prominent electric-lighting company, with instruction to run the various circuits which were to be used in carrying current to the switch-boards and instruments placed in the room overhead. We were furnished with a beautiful copper wire covered by a braiding of cotton yarns saturated with white paint and polished until it shone, a plentiful supply of staples, and such hammers as the stock-room could afford. In stapling the wire to the floor-beams over our heads, we were far enough advanced in electrical knowledge not to drive staples through the covering to the copper intentionally, and were well enough skilled in the use of the hammer to avoid striking the wire and knocking off the insulation in very many cases; though when lying on one's back and pounding in the dark with eyes filled by dust and dirt it was not strange that a misdirected blow would occasionally fall.

Is there any wonder that when a year had passed and I was working as an electrician,—having been promoted from cellar to laboratory—annoying fires would often occur and interfere with the experiments, bringing the necessity of pulling the switches and making the wires "dead" till the defective insulation of the circuits could be repaired? To be sure, these fires would occur most readily where holes in the floor allowed water from the morning mopping to trickle through to the beams below, but it is hardly possible that such construction would be attempted to-day even in the dryest garret.

Installations such as this, often followed by disastrous results, occasioned the fear of fires from the use of the electric current in the early days of electric lighting, and those early days, being so little removed from these present days, remain in men's minds, making them ask, "Can electricity be safely installed?"

Electricity, it must be borne in mind, is always and everywhere convertible into heat by passing it along a medium offering resistance to its progress, while the amount of heat developed is directly

conditioned by the amount of current to be passed and the measure of the resistance to be overcome. The smallest current of electricity passing over the best conducting wire to be obtained raises the temperature, be that rise ever so negligable, but it is very far from being true that this amount of increase of temperature may not be perfectly controlled in circuits which are carrying their normal currents under no accidental circumstances.

The fires which may be occasioned by the introduction of electricity into our homes and workshops may be roughly divided into two general classes,—those arising from an undue amount of current overheating the wires themselves, and those due to current escaping through defective insulation. Consequently the greatest care must be used in laying out a wiring system to avoid either of these causes for trouble.

To recur again to the early days, which even young men may remember, the defective construction above referred to was at fault only in the latter point ; the copper wires were of ample area to carry any current likely to be sent over them and the covering used was one as nearly fireproof as any ever devised, so that had even a considerable amount of overheating occurred there would have been little danger that the high temperature of the circuits would set fire to the building, but it was not realized that currents might escape from the wires and, running along the damp beams, set them on fire through the current which the wood itself was carrying. Indeed, the object-lesson of a tree burning on a wet night set on fire by some escaping current from an electric light wire is even at the present time not altogether unknown.

Very early in the history of the art it was wisely recognized by the insurance companies that a properly installed system of electric lighting might be made at least as safe as gas or any other means of illumination, and in order to guard their interests strict rules have been laid down and inspection of all installations enforced by their agents. On account of this fact there have been a corps of men in their employ engaged in ascertaining all the possible causes for such fires and from their experience formulating the requirements of perfectly safe installations.

In laying out his circuits the electrician's first concern is for the loss of energy occasioned by forcing the current over a wire, and at the same time he endeavors to have the outlay for copper and insulation as small as possible. With any definite percentage of loss it may be possible that the wire employed will be of such a

size as to produce dangerous heating, and to guard against such an effect the rough rule was at first laid down that the density of the current should not be more than 1000 amperes per square inch of cross section of the wire. This rough rule took into account only the heat generated and did not allow for the fact that, while the heat was generated throughout the entire mass of the wire, it was radiated only from the surface, which in any round wire varies as the diameter while the cross section or mass varies as the square of the same dimension.

For comparatively small wires this rule is sufficiently accurate, but through the experimental investigations of Kennely and Forbes there have been deduced formulæ by the means of which wires used under all conditions may be accurately proportioned for any definite increase of temperature, and at present the wiring rules state either the amount of current which each size of wire may safely carry under certain conditions or that the rise in a circuit shall not be beyond a certain amount above the temperature of the surrounding air.

In such perfectly proportioned circuits local increases of temperature to a dangerous amount may be occasioned by the extra resistance of a defective joint between two pieces of wire, and such a contingency can only be guarded against by careful workmanship in soldering all joints which have at first been well secured by twisting or by the means of suitable sleeves and couplings.

In spite of the best designed and best constructed system of wiring, accidental crosses may be occasioned by decay in the insulation or by mechanical occurrences which bring the two wires of the circuit into contact, cutting out the lamps or motors beyond the point in question and throwing the whole power of the machine into a much diminished resistance; a great rush of current follows, and high heating is produced. Similar effects may be produced by crosses with the wires from another system in which the pressure is greater than that for which the wiring has been calculated.

Now, to guard against the evil effect of any such great accidental increase of current it is found advisable to sacrifice some one portion of the circuit in question and avoid the overheating of wires in the neighborhood of inflammable materials. For this purpose, at all the branches in any circuit, as well as at the point where the main wires enter the building or leave the dynamo, small porcelain boxes are placed containing terminal contacts for the

wires and making a break in the circuits which enter and leave them; in this gap between the contacts safety-fuses are introduced into the circuit. These safety-fuses are short pieces of wire made from some fusible alloy capable of melting at a temperature too low to set fire to any inflammable material on which it may fall while melted. Each fuse for any circuit is so proportioned that a definite amount of current will melt it, and in this manner a dangerous increase of current will automatically break the circuit and stop its flow.

Indeed, these little safety-fuses are the most important element for protection against fire in any electric installation, and the greatest care must be used in their location and proper maintenance. Provided the wireman in his haste has not substituted for them bits of copper or handy nails, the installation which is properly "fused" may be considered safe.

Any cause whatever of an increase of current above the normal will make these ever watchful little safeguards surrender their lives to the good of the remainder of the circuit. To be sure they are but mortal and have their almost human failings, and they may persistently burn out if placed in an overheated room; they may not be quick enough to prevent some "sneak" current which follows a minute break in the insulation from setting fire to a board along which it finds its way to a neighboring gas-pipe, but in the main they are true monitors and their warning should be heeded.

The "leaks," "crosses," and "sneak currents" spoken of above are all fertile causes of electrical fires, and are occasioned by defects in the insulation of the wires which result in currents passing over resistances so great as to cause undue heating. Either by the "crosses" sending too great currents over wires properly proportioned for their normal work or by the "leaks" sending currents of electricity over semi-conductives, such as damp woodwork, while the "sneak currents" are minute leaks which do not send a sufficiently great amount of current astray to increase the amount in the circuit sufficiently for blowing out safety fuses.

While the safety fuses are the reliance when these accidents occur, yet in the normal and possible circuit the fuses are never called upon to perform their office. Insulation is the means of prevention of all these dangers; insulation is the great need in a safe installation; to the insulation we must look in installing our plant, and to the maintenance of the insulation we should devote our energies after the circuit is in operation.

As modern plumbing, gas fitting, and steam piping have revolted against concealed work, so the first method which has been successfully adopted for safely running wires in buildings and the method which is always used in factories is to run the wires in plain sight, and when porcelain or other non-absorbent insulators are used in supporting the wires to keep them away from contact with the surrounding woodwork or walls a very high degree of safety is obtained. There is the single objection to this method of construction in the power the electrified wires have of attracting and retaining floating particles of dust or lint, such as are often continually flying in the air of a manufacturing establishment. I have seen wires in such a place, which originally were hardly more than a quarter of an inch in diameter, attract cotton lint till they were more than an inch across, having the appearance of some hairy caterpillar creeping along the beams of the floor above, and I have known such dust-laden wires to carry a small fire in all directions till, before the original blaze could be extinguished, a half dozen other fires had been kindled and the building was doomed to destruction. Of course such an effect is only indirectly due to the electric installation, but, had the danger been appreciated and the wires kept free from such attracted particles, the small amount of labor necessary for the task would have saved thousands of dollars.

In an office building or a house, however, these unmasked wires interfere too much with the surrounding decorations or wall finishings, for, wherever the circuit is run, lights are needed in many places in the room, and the network necessary on the ceiling is apt to be very unsightly, especially as it seems impossible to run and keep the wires straight in all changes of temperature unless they are supported through their entire length, so that the expense of endeavoring to produce a decorative piece of work in such a manner amounts to as much as that necessary to do concealed work safely.

For concealed construction the first method used was to incase in a lead pipe the wire which had been previously carefully insulated with rubber on a saturated fiber; such a lead covered cable was then buried in the plaster of the walls or placed behind the lathing with the ends brought out to the various switches and lights. Though thus to cover the wire with a double waterproof protection of an insulating material and an impervious lead pipe may seem at the first sight an ideal method of installation and

one likely to be enduring in its properties, yet I have seen short circuits cause the plaster to fly in all directions from the walls of one of the handsomest public buildings in the country when the current was first turned on the circuit; and though the electric plant had cost thousands of dollars, it was soon almost beyond repair, and in the place of these buried lead cables it became necessary to use a most unhandsome external circuit in preference to tearing out and replacing the defective wires; which alternative would have necessitated replastering a large portion of the building. And yet this trouble was not due to any defect in the method or the original properties of the lead cables, but to the impossibility of obtaining perfect workmanship and absolute care on the part of all the men, carpenters, lathers, plasterers, and electricians, who had been engaged upon the immense building.

At the present time the likelihood of defective workmanship and mistakes is recognized much more fully, and it is not attempted to build an inflexible system into the walls of any building, but methods have been devised by which it is possible to withdraw defective wires and replace them without injury to the walls or woodwork of the building. Of course something must be fixed in the installation, but it is preferred at the present time to fix the conduit conveying the wires rather than the wires themselves or their insulation.

In old buildings where gas has already been installed and it is not deemed advisable to tear out the walls for a system of conduits there has been devised a neat molding having two grooves into which the wires may be laid, where they are then covered by a cap running lengthwise of the molding, and which, when completed, may be painted or made to harmonize in any other manner with the neighboring decorations.

While this molding system of conduits is extensively employed in old buildings and along wooden walls such as are found in our magnificent river and sound steamers, it is generally regarded with less favor than a system of round tubes made of some insulating material which are run under the plaster and terminate in junction boxes from which the wires may be pulled through the tubes. This is perhaps the safest and most satisfactory system for wiring any building, and this method combines the least possible interference with the decorations together with the greatest immunity from fear of fire. The tubes here spoken of are made in some cases of paper strips wrapped spirally around a mandrel, the tube so con-

structed being plunged into melted asphalt which is maintained at a high temperature; some are made of a low grade rubber, and others of a combination of a paper tube with a rubber sheath, and the whole finally finished by a braided covering. The two latter tubes, being flexible, do not require any elbow pieces at the bends and present a smoother internal surface for drawing in the wires, but they possess the disadvantage that, on account of their flexibility, they are not so capable of resisting accidental blows or misdirected nails while the plant is being installed.

When such a complete system of tubing has been installed in a house and connected to the junction boxes, there is provided a continuous insulating and waterproof conduit passage for the wires from their original entrance into the house to the last light. The fuses, which must be as carefully attended to on this system as on any other, prevent any great rise in the temperature of the wires due to any external causes; while the tubes themselves offer no path for the leak through a defective insulation, and, in consequence, any system so installed may be considered to be perfectly safe against danger from a fire caused by the electric installation.

As we have said already, the fact that electricity is always convertible into heat by passing a current over a resistance, taken into account with the defective character of the early installations, has served to turn men's minds to electrical fire risks and made them inquire into the means of prevention of such fires; it is therefore useful to examine the statistics of our fire insurance companies and note what proportion of fires are of electrical origin.

From 1884 to 1889 the Massachusetts Insurance Commissioner's report shows that out of a total of 12,935 conflagrations in the State there have been 42 traced to electric wires,—scarcely half of one per cent. While it is yet more striking to notice that in 1887 there were 14 fires of an electrical origin, and in 1889 there were but 7 such fires in approximately the same total,—but one more than in 1884,—and this too in the face of most enormous extensions in electrical installations.

In this connection it is interesting to note the other causes which are comparable to electricity in producing fires, and one is astonished by their triviality.

Kerosene oil (breakage and explosion)	947
Careless use of matches	437
Curtains or goods exposed to gas or candle	224
Thawing water-pipes	89

Clothes drying near stove	64
Fat boiling over	43
Cigar-stub in wooden spittoon	41
Smoking in bed	34

And it is further noticeable that the most important of these causes are accompaniments of other methods of illumination.

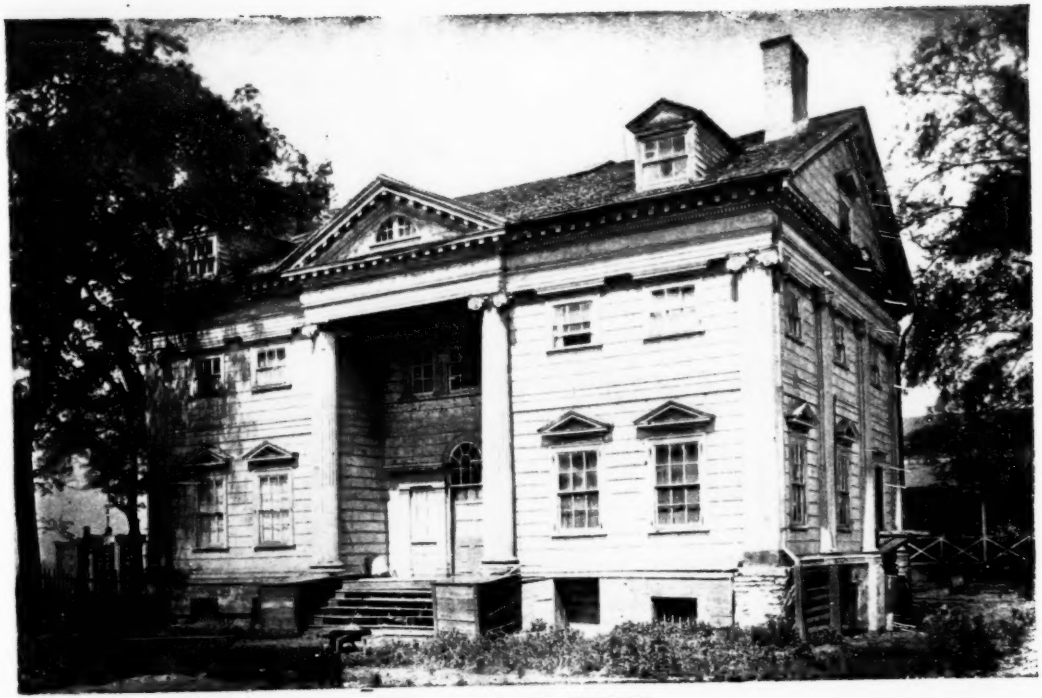
To be sure, it is true that even the most trivial cause may be the origin of the largest fire, as in the oft repeated story of the great Chicago fire, which was started in a stable by an overturned lantern, and as was recently the case when in Lynn, Mass., "a draft from an open door blowing the blaze of an oil stove down around the burner, causing the stove to explode," originated the great fire which consumed so many of the shoe factories of that city in 1889.

In his report for that year the Insurance Commissioner, after commenting on that Lynn fire, says: "In the case of Boston the preponderance of testimony seems in favor of the theory that it was caused by the electric wires; and, if this be the true theory, then it follows that two fires, which together destroyed over eight million dollars, could easily have been avoided."

Indicating therefore that in the judgment of this high insurance authority, Mr. George S. Merrill, a fire from an electric installation is practically always preventable if the work is properly done and the installation regularly tested. We believe that we may truly say therefore that an installation for the electric lighting of any building may be made perfectly safe as regards fire risks; using the word "perfectly" in the human sense, for we know nothing connected with either science or our daily lives in which every form of possible accident may be absolutely guarded against.

Such a perfect installation we now understand to be one in which the wires have been properly proportioned to carry their normal current without undue heating; where also fuses are placed on all the branches to blow out whenever the current rises dangerously above that normal; and where not only the insulation of the wire is thoroughly waterproof, but where also its supports are of an incombustible waterproof character and so arranged as to keep the wire out of contact with all combustible materials; and, above all, where by proper inspection, cleaning, and testing, the installation is maintained in its original character throughout its entire life.

To be safe, then, good and honest workmanship must be maintained by constant watchfulness and not by fancied security.



OLD COLONIAL STYLE MANSION-HOUSE.

[Washington's Headquarters. Ninth avenue and Ninety-first street, New York city.]

MODERN AMERICAN COUNTRY HOUSES.

By John Beverley Robinson.

LET us take up the designing of a country house as an architect takes it up in each individual instance. First, as to arrangement : and, before we can do very much definitely with that, we must have some notion of the general appearance of the house as we wish it to be ; whether a blocky mass, after the fashion of the quasi-classical house of a century ago, such as the old house until recently existing in the upper part of New York City, or whether a thing of points and gables tossed together skilfully and artistically, such as the more modern house at Short Hills, of neither of which examples do I know the name of the designer ; whether low and rambling, or piling up pyramidally. No matter which the surroundings and circumstances may lead us to select, we can make a good thing of it as a design outwardly if we are clever enough.

Having made sure of what we want as to general effect, and, if we know what we are about, having been influenced in the choice by no considerations of fashion or imitation, but solely by the consideration of what will best suit our location, we try what sort of an interior we can devise that will work with such an exterior as we are aiming at.

We would like perhaps a square entrance hall, with no vestibule, a large dining-room, and a larger drawing-room,—as it is now the fashion to call it, reviving the name by which it was known to me in boyhood. Besides we want a library, to be used also as a smoking-room, a sitting-room,—or morning-room as it is called in England, although the functions are not quite the same, as the English morning-room is used for breakfast and luncheon, as well as for general use between meals. There will be bedrooms wanted, of course, as many as we can get, probably more than can be placed above the lower rooms in one story.

With all there will be a strict money limitation, so that it will be no wonder if we have to weigh each requirement, relinquishing some, modifying others, insisting upon a few in order to make the outside, the inside, and the appropriation harmoniously fit together.

MODERN COUNTRY HOUSE AT SHORT HILLS, NEW JERSEY.

In arranging our rooms some of the English customs may be studied to advantage. In American homes the desire for wide sliding doors between the principal rooms is very general. The effect, when these doors are open, is spacious and pleasant, and the practical utility when the whole house is open for entertaining is evident. In England such wide doorways are unusual ; each room is separate, giving a new scene and new interest as we pass from room to room. A typical American design is shown in the plan of a house at Englewood by Rossiter & Wright.

In our larger country houses there is a tendency to approach the English model in many respects, like causes as usual producing like effects. Such a tendency is shown in the plan of a country house in West Virginia by C. T. Mott. The reproduction does injustice to the magnitude of this house, the great hall being about sixty feet long and the dining room about forty. The development of a class of people of independent means and not depending on their labor for their living is producing very much such a house as the same class, long existing in England, has found best suited to its tastes there. The most marked feature is the double entrance,—the carriage-porch and the garden entrance, the one for the mere business of entering, the other the approach to the pleasure grounds, park, garden, or often merely what we would call a yard.

How spontaneously similar circumstances generate similar solutions is illustrated in the plan of a country house to be used as a shooting-box, designed by the writer. There was no especial attempt to imitate English methods. Given a large forest tract, where wild game abounded, a taste on the part of the owner for the chase, a house to be used chiefly for the gratification of this taste, the plan naturally follows. One story high, because there is no need of condensing into two or three. No cellar to speak of, because the coolness of the summer requires none for keeping things cool, and, the occupation being only in summer, no cellar is needed for heating apparatus, or as a frost-proof place of deposit. Immediately we have what is essentially the English country house. A large hall, paved upon the surface of the soil, properly prepared, in this case paved with brick ; long rambling corridors, running off in one direction to bedrooms, in another to kitchens and the other offices, a dining-room, and a quite subordinate drawing-room, a boudoir for the ladies' use, a cosier refuge than the great hall. Finally come the stables and kennels enclosing the graveled quadrangle.

HOUSE AT ENGLEWOOD, NEW JERSEY.

[Rossiter & Wright, Architects.]

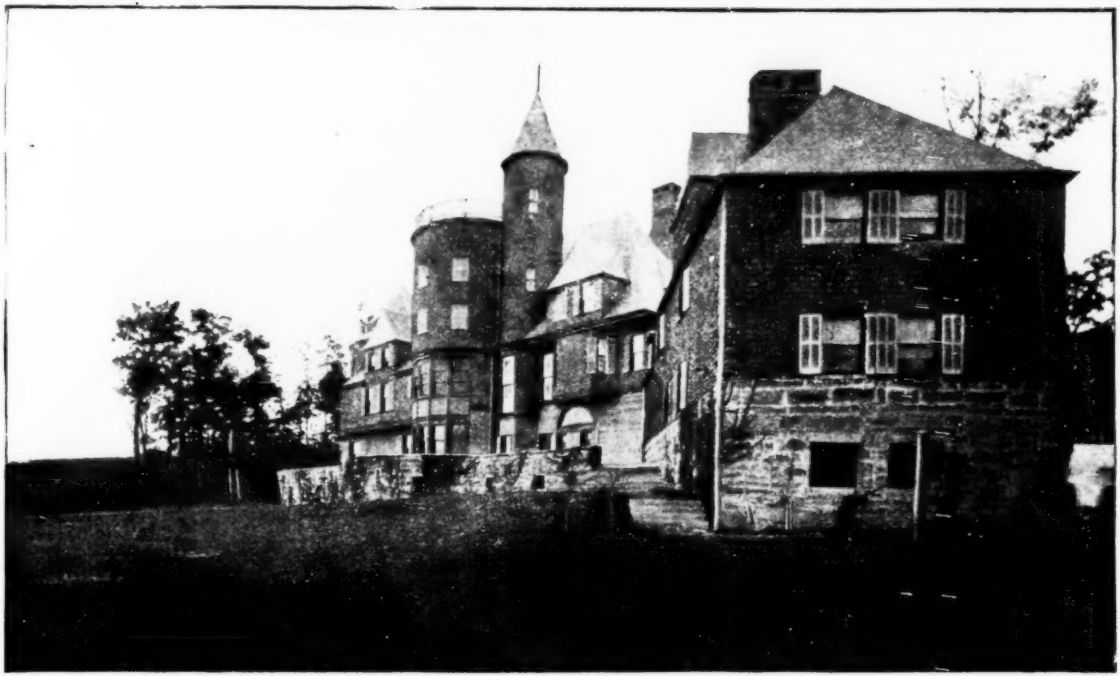
The Hempstead house, by the writer, gives the double entrance again, the garden front—always the principal part—upon the lawn, the real entrance with covered carriage-porch in the rear.

Some English arrangements will not bear copying,—their manner of separating the dining-room from the serving-room and kitchen, for instance. In a way that is manifestly studied, but for what real reason the American mind finds it hard to guess, their dining-rooms are placed so that all the dishes must be carried across the main hall, through the only door which is provided for entrance. Inquiry has disclosed that a dining room with more than one doorway is looked upon as "a terrible place for draughts," and in a country where unwarmed halls and bare neck and arms for dinner are the custom such considerations are necessarily paramount.

When we come to actually carrying out whatever plan we finally work out, the expediencies to be weighed and questions to be settled are innumerable. For most of them no perfect solution can be found; it is, at the best, accepting the inevitably imperfect. In every case, too, we must aim at the reasonably practicable financially; the very best way is often too costly to be prudent, even if there is money at hand to pay for it.

For the material of the outside, stone is rarely available. Rough

FIRST STORY PLAN OF HOUSE AT ENGLEWOOD.



COUNTRY HOUSE IN WEST VIRGINIA.

[Charles T. Mott, Architect.]

field stone when found on the spot may do well enough, but even then it is far more costly than the framed construction. The latter is the usual resort, covered with shingles, or rough cast or clapboards, if we can condescend to such banality. There is nothing more generally available than shingles ; cypress lasts longest and greys well with the weather. Although white pine gives a whiter and more silvery grey, it is not so enduring. Cedar shingles turn blackish rather than grey, and are better stained.

Cement, plain or covered with pebbles, does well for parts or

HOUSE AT TUXEDO, NEW YORK.
[Bruce Price, Architect.]

for the whole, and suggests masonry in a very satisfactory way. I have a notion that slate could be used more than it is for covering the sides of houses, as well as the roofs. The trouble is the objectionable color of the ordinary black slate,—the excessive uniformity of the market slate of all kinds. There is beautiful slate to be obtained which is regarded as waste by the quarries, very much as until recently the most beautiful brick were rejected by the kilns because they did not meet the demand for uniformity of color. These inferior qualities, as they are considered, I have reason to

believe are of as good quality as many others for wear. After a year or two they change color irregularly, fade into soft blue greens, olives, or browns, which make with the original green or purple a color effect which it is a joy to behold.

That people really do not care for perfectly uniform color is shown when the plaster walls of a church or hall are to be painted. The painter will mark them off into blocks and then carefully paint each block a slightly varying tint, and people will admire it accordingly. It is only the exaggerated and misplaced passion for neatness, which demands that grass shall be as green as possible,—

HOUSE AT LAWN RIDGE.
[Rossiter & Wright, Architects.]

as near in appearance to a painted board as it can be made,—that makes us forget our real inward appreciation of the beauty of surface color that is not uniform.

They have a way in the West of veneering houses with brick, which is a perfectly legitimate and available resource. There they use it to imitate a brick construction, but such a fatal attempt at imitation is easily avoided. Properly used, a veneered brick house will have a character of its own and can be made no less satisfactory than shingles.

There is one point, trifling to the unprofessional mind but very

important to the professional. I speak of what are called flashings. These are the metal sheets used for making tight joints in the angles of roofs, about chimneys, and in other places. Tin, however well painted, is sure eventually to rust into holes. Zinc is rustless and cheap, but apt to crack in putting on. Lead is good for many reasons, but best of all is copper. Use copper, if your purse can stand it, by all means, for flashings, gutter-linings, and all similar purposes. If not copper, lead and zinc judiciously used are always available,—zinc in small pieces, where much bending will not be needed; lead over doors and windows and built into chim-

HOUSE AT ORANGE, NEW JERSEY.
[W. C. Hazlett, Architect.]

neys for what are known as "cap-flashings." These make tight and permanent work.

In the interior the chief part of the work is plastering; the chief part, that is, in superficial measurement, as five sides out of six in each room are usually plastered. Of late years what are called hard plasters have been introduced. These are said to be substantially of the same nature as the well-known Keene's cement,—that is, of plaster of Paris mixed with alum and reburned. Asbestos fiber is mixed in to take the place of the usual hair. There are various makes of hard plaster, all of which are said to be good;

THE NEWCOMB HOUSE, ELBERON, NEW JERSEY.

the only one of which I can speak from experience is the "Windsor cement." Of this, one virtue I can distinctly affirm ; and doubtless there are others which have the same advantage. It does not fall from the ceiling, no matter how much it may have been saturated. In other ways the hardness is of advantage, especially against the bruises and marrings caused by accidental knocks from furniture or otherwise. Hard plaster, however, has two drawbacks: the first is that workmen are apt to put it on as ordinary plaster is put on, which is sure to make it worthless ; the other is that the harder and better it is the more it transmits sound through partitions and floors. With floors this is easily remedied by a layer of soft felt paper ; in partitions no convenient and inexpensive remedy presents itself.

Floors come next to plastering, and are much more difficult to make satisfactory. Double floors of course we must have,—the under floor as rough as you like, only the boards must be of even thickness, and it is better to lay them diagonally than across the beams. Laid across, each wide board is sure, when it shrinks, to gather three or four of the narrower boards of the top floor together, making a wider crack than usual at that point. When they are laid diagonally, this difficulty is avoided. On this rough floor we will lay a thickness of deafening paper,—asbestos, if we can afford it. The real trouble comes with the top floor. No matter how much care is used in drying the material, cracks are almost sure to appear after a winter or two of furnace heat. The narrower the boards are, the narrower of course the cracks will be, and the more expensive the floor. In fact, if we must have the best floor possible, I should use the parquetry floor put down by experienced men who do nothing else. The cost would not be prohibitory, even for an ordinary fortune ; not so very much in excess of a hard-wood floor in very narrow strips. It is possible that something in the way of a continuous paper floor may be seen in the future : the inherent defects of a wood mosaic are insuperable. Such a paper floor I fancy I could construct, but such new devices are not commercially available until somebody devotes himself to manufacturing them.

One word about windows. The usual guillotine sash, though the most convenient, is the ugliest thing possible. You may take your choice, beauty and draughts, or ugliness and what the yachtsmen call "weatherly qualities." On the other hand nothing can be prettier than the casement sash, opening outward, seen in the house

HOUSE AT SHORT HILLS, NEW JERSEY.

at Tuxedo, by Bruce Price. They are out of the way, too, of curtains and furniture, but, besides the other defects which almost all casements have,—of not being tight and of slamming and breaking the glass,—they have a curious and unforeseen drawback,—it is impossible to wash them on the outside without a ladder, or taking them off their hinges and lifting them bodily indoors. A pretty arrangement which avoids this inconvenience is sometimes available. The window is divided into four parts in width ; the middle pair of sash open outwards, the two sash at the sides open inwards, but are only intended to be opened for the purpose of washing the middle pair.

All the rest of the construction of the house—doors, stairs, closets, pantry arrangements, dumb-waiter, and such trifles no doubt they seem as door-knobs and sash-fastenings—I pass over, but to each the architect must give some consideration. Blinds deserve a moment, since they are the cause of much annoyance to both architect and owner. For the purposes for which blinds are devised nothing is equal to the ordinary outside blinds with movable slats. They exclude the sun and admit plenty of air ; even in a hard rain the sash may be left open inside of them,—an important matter in summer. Yet they have serious disadvantages. They detract from the appearance of every building upon which they are hung ; they slam and rattle in the wind and are awkward to reach in order to close them. In some situations, too, they are impossible,—upon a bay-window, for instance, where the space between the windows is not sufficient for the blind to fold back against, or in one of the pretty triplet or multiple windows, with mere mullions between, that so frequently adorn foreign work. In such cases we must resort to inside blinds of some kind ; the ordinary four-fold, with interstices too small to admit much air, and entirely unable to exclude rain ; the English Venetian, drawing up with cords, admitting air and rain too, and accumulating dust in an astonishing fashion ; or finally rolling or sliding blinds, costly and hard to find a place for,—how hard nobody knows who has not tried.

After the main part of the actual construction has been determined the no less important matter of appliances is to be thought out. By appliances I mean gas-fitting, plumbing, drainage, and heating. Sanitary plumbing has been pretty well exhausted as a topic, written and rewritten to revulsion. With drainage the case is much the same, but there is an interesting new development in

this matter of drainage and sewage disposal which is beginning to be talked about and used, and will bear explanation.

Formerly there were but two methods generally available for disposing of sewage, where there was no sewerage system: by the ordinary cesspool, with various modifications, and by the subsoil-irrigation system. Both of these are too familiar to need elucidation. The new method involves a new principle; it cannot be found in books, only in fugitive articles, and buried in dry reports and archives. It is used and advocated by a few experts, seems to give satisfaction, and may be the coming system. It is called the method of intermittent downward filtration and is based upon the

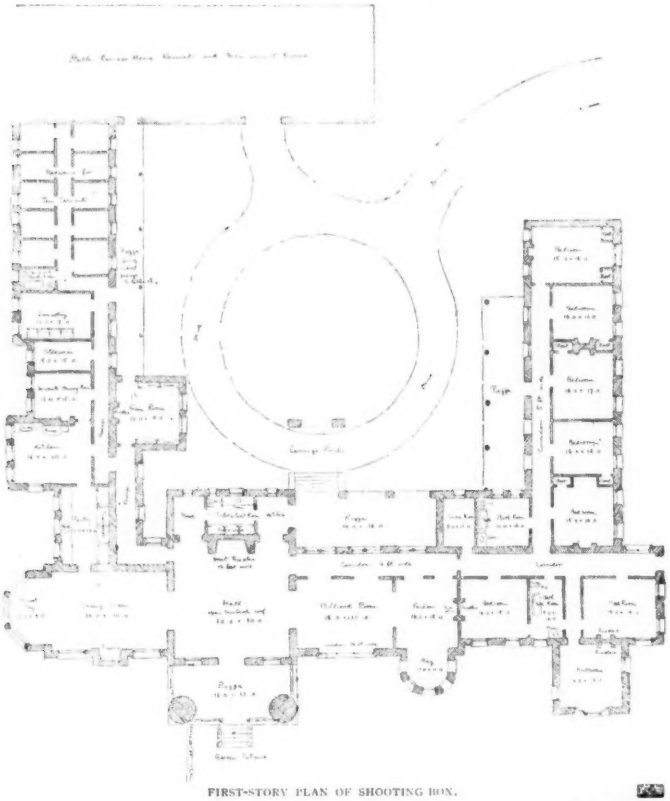
HOUSE AT HEMPSTEAD, LONG ISLAND.
[John Beverley Robinson, Architect.]

discovery that the soil does not become foul with sewage, if a certain time elapses between each deposit. In this interval the sewage-eating microbes have time to multiply and to dispose of the previous dose of sewage, leaving the soil pure and ready for the next deposit. The mode of obtaining this interval and the exact disposition varies in each case, according to the extent of the establishment and the nature of the available soil. The method is used for disposing of the sewage of whole towns as well as of single houses.

For warming the house, there is nothing on the whole that can equal the hot-air furnace. The complaint of dry air and overheating are faults in management that are not inherent in the

FIRST-STORY PLAN OF HOUSE AT HEMPSTEAD.

apparatus itself. The one great advantage of the furnace is the continual supply of good fresh air that it pours into the house. With ordinary fireplaces to serve as outlets for the displaced air, there is no better system of ventilation. When there is no fireplace, some kind of an escape for air should be provided, opening near the floor, and not at the ceiling. This is important, as where



FIRST-STORY PLAN OF SHOOTING BOX.

the opening is near the ceiling it simply drains away the hot air without disturbing the general atmosphere of the room. When it is near the floor, the air does not tend to escape by it until forced out by the pressure of the hot air accumulating in the upper part of the room.

SHOOTING-BOX IN DELAWARE COUNTY, NEW YORK.

Hot water has many advantages. Although the first cost of the plant is greater, it costs less to run than any other method; there is not the overheating and alternate chilling of steam, or the escape of coal-gas to which furnaces are liable. If it can be arranged to admit air, it is better than the furnace. Sometimes this can be arranged by valved-openings through the walls behind the radiators, sometimes by a large hall register supplied with hot air from a radiator in the cellar. Steam-heating is not to be recommended for private houses, except by the indirect method, when it becomes to all intents a hot-air furnace. With both hot water and steam the disposal of the radiators is always a question. They are ugly things at the best, and even bigger and uglier for hot water than for steam; ugliest of all are the "decorated, marble-topped" affairs which some manufacturers admire so much. Apart from their inherent ugliness, the best place for them is the very place where they are least wanted,—just in front of the window. A reasonably good compromise is to put two radiators, one each side of the window, making the best of their inevitably objectionable appearance: this disposition, too, avoids the usual difficulty of the window-sill not being high enough to stand a large enough radiator against.

Pages might be filled with such considerations upon the fifty or a hundred items that go to make up a house: that which I chiefly wish to convey is that each way of doing each thing has its advantages and its corresponding disadvantages. The work of the architect is to balance these as best suited to the matter in hand, so as to secure a practically, esthetically, and economically harmonious result.

ELECTRICITY.

Conducted by Franklin L. Pope.

THE history of the invention of the modern incandescent electric lamp is a curious one. In 1878 the announcement, telegraphed all over the world, that Edison had invented an electric lamp which was to supersede gas as a domestic illuminant caused a wild panic among the holders of gas shares, who hastened to sacrifice their long-treasured securities at almost any price. As it turned out, he had at that time done nothing of the kind, but early in 1880 he actually did produce the long-promised lamp. Patents were obtained, companies organized, and a great business rapidly built up. For six years no serious efforts were made to enforce the patents, and meantime competing companies sprung up and flourished on all sides. Then came the beginning of a long, tedious, and enormously expensive litigation, which at the end of another six years ended in the complete triumph of the Edison patent, which was upheld in the court of last appeal. By due process of law the competing manufacturers were one after another enjoined, their factories closed up, and their employés turned adrift. Suddenly one of the concerns thus attacked turned upon its pursuer and aimed a deadly blow at the vitals of the Edison-lamp patent, alleging that the invention had not only been made, but had been publicly exhibited and operated in the streets of New York, by an obscure German watchmaker more than thirty years ago. The judge who first heard the new defense deemed the defendant's evidence insufficient, and declined to withhold his injunction, but on a second and subsequent hearing before another judge in another district an injunction was refused, thus rendering it necessary to have the whole case retried on its merits, in view of the new evidence. That the electric lamp alleged to have been made and used by the watchmaker is identical in all essential respects with the modern commercial incandescent lamp is admitted by all the experts, and hence the case is now narrowed down to the sole issue of priority of invention and public use on the part of Henry Goebel as against Thomas A. Edison. It goes without saying that the further proceedings in this most unusual case will command world-wide attention.

REFERENCE was made in these notes last month to the prevalent craze for the construction of electric street-railways, which is leading to the exploitation of them in many localities where there is no possible chance of their ever proving remunerative investments. The recently published annual report of the Massachusetts Gas and Electric Light Commissioners, containing the statistics of last year's operations of the electric-light companies of that State, shows that exactly the same thing has been done in that industry. There is an unwritten law, which in some cases has become crystalized in the statutes, which prescribes that the fare on an electric car shall be five cents, no more and no less, irrespective of the actual cost of the service rendered, and in like manner the price of electricity for illuminative purposes has somehow become established by custom at one cent per ampere hour. While it is possible that this rate might be found to be fairly remunerative in large cities or under exceptionally favorable conditions, the Massachusetts returns show conclusively that it is a ruinous one to the smaller enterprises, and that most of these, taking into account inevitable depreciation, must be running more and more behind with every year's operations.

OF the eighty-four companies engaged in supplying electric light and power in Massachusetts in 1892, only sixteen have been able to earn dividends of 6 per cent.

or more, while sixty-one have paid no dividends at all. Most of the smaller companies have already overloaded their plants, and are now confronted with the serious question whether it is worth while to add to their already unprofitable investment in order to accommodate new custom. Like the English sportsman in the jungles of India who has the tiger by the tail, they do not know whether it is best to hold on or let go. If they raised the rate to a paying point, which would probably necessitate an advance of 50 per cent. on the present figure, not only will they be denounced as conscienceless monopolists and extortioners, but their customers will in too many instances revert to their old-time habits of burning kerosene and going to bed at 9 o'clock. That the situation is a sufficiently serious one is shown by the fact that more than $1,000,000 has been invested in electric-lighting plants in various Massachusetts towns on which the net earnings at the present time, leaving repairs and renewals out of the question altogether, do not exceed 1 per cent. per annum. Yet the conditions of success and prosperity in this industry are, to say the least, fully as favorable in Massachusetts as in any other section of the United States.

IT is not difficult to foresee that there must ultimately be a severe check to the present electrical boom. An enormous amount of capital is being put into electrical enterprises of one kind and another which have no inherent possibilities of ultimate commercial success. The manufacture and sale of machinery and supplies for the equipment of all these non-paying electric-light companies and electric railways makes business lively and apparently prosperous for the time, but, when the inevitable day of reckoning comes, it is much to be feared that the financial results will lead capitalists to entertain an ineradicable distrust of legitimate as well as illegitimate electrical enterprises,—a consummation for many reasons greatly to be regretted.

AN immense dynamo has been installed at the aluminum reduction works in Neuhausen, Switzerland, which is driven by water-power derived from the falls of the Rhine at that place, and which supplies a current of 7500 amperes and 55 volts to the electric furnace. A notable peculiarity of the construction is that the main shaft of the dynamo is vertical, and is coupled directly to the shaft of a turbine of 550 horse-power. The rotating part of the machine weighs eight tons. It is probable that dynamos of this general type will be used in the Niagara Falls plant, now in process of construction.

RECENT statistics give the aggregate dynamo capacity of all the electrical central stations of London as 852,000 lamps of 8 candle power, of which about 504,000 have been installed. Taking the average of all companies, there are 1100 lamps per mile of conductor. This figure varies greatly, as might be expected, in different districts of the city. Only 23.7 per cent. of the total number of lamps are ever in use at any one time.

THERE are now eight municipal lighting-plants in operation in Great Britain, viz.: Bradford, Brighton, Dublin, Dundee, Glasgow, Hull, St. Pancras, and Taunton. The aggregate population of these cities is over 2,000,000. Municipal plants are also in process of erection in Bristol, Manchester, and Portsmouth, and proceedings for their establishment are being taken by a number of other cities.

AN experimental railway 1½ miles long has been constructed on Long Island, which is to be equipped with electrically operated cars arranged upon the principle of the bicycle. Each car is supported upon two grooved wheels arranged fore-and-aft and running upon a single rail. Parallel to the track-rail and nine feet above it is the guide and trolley rail. The car is 65 feet long and weighs about 3½ tons. The driving wheel is five feet in diameter, and is provided with a pair of direct-coupled electric motors, capable of developing 75 horse-power at 560 revolution per minute. It is expected that a

speed of 100 miles per hour will be attainable.

THE German military authorities have been experimenting in electric illumination from captive balloons, with a view to the employment of the method in siege operations. A light of 5000 candle power placed at a height of 600 meters was found to light an area of 500 meters in diameter in a most satisfactory manner, while half a mile of road was lighted from a height of 150 meters.

IN some of the Glasgow ship-yards an electrically-driven rotary planer is now used for smoothing the decks of ships,—an operation which when performed by hand is exceedingly laborious. The machine looks like a lawn-mower and is handled in much the same way. This suggests that there the invention of an electrical lawn-mower would not only meet a long-felt want of the suburban resident, but would at the same time assist in improving the load curve of the local electric-lighting station.

A SOMEWHAT singular scheme for electric lighting has been proposed by a prominent electrician for the city of Belfast, Ireland, the adoption of which may not be improbable. A number of independent electric stations are to be placed in different districts of the city, the motive power for which is to be furnished by gas-engines. There are some things to be said in favor of such a plan, but on the whole, in enterprises of this kind, a policy of concentration has been found to lead to more economical results than one of dispersion.

THE experience of managers of electric plants in the States along the Atlantic seaboard have drawn attention to the singular fact that thunderstorms are largely a result of peculiar local conditions. Instances have been known of two stations less than fifty miles apart in one of which troubles and interruptions from lightning during the summer months were almost incessant while the other was almost entirely free from any such disturbance.

A NEW manufacturing establishment recently completed in New Jersey has been equipped throughout with electrical appliances for the distribution of power, shafting and belting of every kind being wholly dispensed with. Thick copper rods extend throughout the buildings, which are tapped, whenever required, to furnish a supply of electricity to the motors, with which each separate machine in the factory is equipped. Careful computations show that the loss of power in transmission is much less than by any of the old methods.

SOME very interesting tests have been made at Johnstown, Pa., with an apparatus for electrically welding the ends of rails, after they have been placed in position in the track. It is found that about three minutes is required to bring the abutting ends of the rails to a white heat; the ends being then brought into contact under a heavy longitudinal pressure, a perfect weld is effected without difficulty. If the use of a jointless continuous rail should prove to be open to no objections on the score of expansion and contraction under changes of temperature, it will not improbably constitute one of the most important improvements which has ever been introduced in the construction of railways.

ACCORDING to the electrical journals another attempt is to be made to operate one of the New York city street railways by storage batteries. A section of the Second-avenue line is to be equipped exclusively with electric cars, for which a complete and well-designed plant for charging and handling the batteries has been erected. The enterprise is apparently in competent hands, and is said to have strong financial backing. It is certainly to be hoped that this undertaking may be more successful than its predecessors.

A STORAGE-BATTERY of seven cells exploded in Washington, D. C., while in the process of being charged, a spark caused by an interruption of the circuit having set fire to the uncombined gases in the cells. The explosion was a violent one, but fortunately none of the attendants were

injured, beyond being deluged with dilute sulphuric acid.

THE annual report of the General Electric Co. to February 1, 1893, shows 1277 central stations using apparatus supplied by it, operating about 110,000 arc- and 2,500,000 incandescent-lamps. The company has also furnished apparatus for 435 electric railways, aggregating 4927 miles, and operating 8356 cars. Two electric locomotives of 1600 horse power each, ordered by one of the principal trunk-lines,—presumably the Baltimore and Ohio,—are nearly completed.

EXPERIMENTS are being made in Chicago with an electrically propelled vehicle for ordinary street use. The wagon weighs 2500 pounds, and the power is supplied by a storage battery weighing 850 pounds. In view of the ill success which has hitherto attended all attempts to operate street-cars profitably by means of storage batteries, we do not look for an immediate and radical revolution in the methods of ordinary street transit as the result of this application. Yet the time will doubtless come when substantially all highway traffic will be carried on by electric power.

ONE of the most famous exhibits at the Electrical exhibition in Philadelphia in 1884 was the "jumbo" dynamo of the Edison Electric Light Co., which had a nominal capacity of 1200 16 candle-power lights, and was at the time regarded as a remarkable achievement. The art of dynamo designing at that date was not very well understood, and hence it is not to be wondered at that the weight and bulk of this machine, as compared with its output, was excessive. Within a short time other dynamos of equal capacity were designed, whose gross weight was little if any more than that of the armature alone of the "jumbo." The progress made in the art during the eight years which have elapsed since the building of the "jumbo" is strikingly illustrated by the central exhibit of the electrical station at the World's Fair, which consists of a 2000 horse power engine belted to two immense dynamos, having a capacity of 10,000 lights each.

A NUMBER of the most expert telegraphic operators of the country have recently participated in a competitive prize exhibition, at which some really remarkable work has been done. E. D. Moore, in one trial, transmitted 234 words in five minutes without an error, which is at the rate of a word in 1.3 seconds. To appreciate the wonderful skill of this performance it is necessary to inform the layman that the average number of distinct movements of the wrist and hand to form a single letter of the telegraphic code is six, and that ordinary words will average at least five letters each, and hence that Mr. Moore was compelled, not only to make no less than twenty-three distinct muscular movements per second, for a period of five minutes, but each of these movements must have been timed with extreme accuracy, seeing, for instance, that a variation of 1.25 of a second in timing might have converted the letter "i" into "o," or "c" or "r" into "s." Very nearly as good work was done by Mrs. E. Sandberg of the women's class.

THE legislature of Massachusetts has affixed a proviso to every street-railway charter which has been granted during the present session that the road shall not be sold or leased to a foreign corporation. It is not unlikely, however, judging from past experience, that some way will be found to evade this proviso. It will be remembered that during the past year the control of some of the most important electric street-railway systems of that State have passed into the hands of a New Jersey corporation.

A BILL is pending in the Massachusetts legislature, which will probably become a law, providing for the placing underground of all the electric wires, with the exception of trolley wires, within the business portion of the city of Boston. It is provided that the work shall be supervised by a commission, composed of the city engineer, the superintendent of streets, and the inspector

of wires, and that the work shall be completed by January 1, 1900.

THE aggregate receipts of the electric-light central stations of Massachusetts for the year ending June 30, 1892, is reported by the State commissioners as $2,970,-637.94, and the expenses as $2,015,402.86. Nearly all the money has been made by a dozen or so of the larger companies, the smaller ones, as a rule, being rather unprofitable enterprises. The number of incandescent lamps in service foots up 224,-966, as against 161,259 in 1891, and 118,529 in 1890. The number of gas companies which have also undertaken to supply electricity is 23. A considerable number of towns have taken measures looking to the establishment of municipal plants for the supply of electricity, both for public and private purposes, and some such plants have already been installed, though with what result it is yet almost too early to determine with certainty. The number of fatal accidents during the year was 4, of which 3 occurred to employés through their own carelessness, and the other to a citizen who foolishly put his hand on a live wire out of curiosity. In six cities a considerable portion of the lines in the thickly-settled portions are in underground conduits. The returns of the gas-companies show that their receipts for the sale of gas by meter still continue to increase, in spite of electric competition, though there is a marked falling-off in the receipts for gas furnished to public lamps, the arc-lamp being apparently preferred for street lighting in all places where it is available.

A NEW standard cell for the determination of electromotive forces has been devised by Edward Weston, which is free from the temperature error of the Clark cell. He makes use for this purpose of the salts of cadmium, which, when in solution, retain the same density through a wide range of temperature. Mr. Weston's tests show that the variation in electromotive force in such a cell does not exceed 1-100 of 1 per cent. through a range of over 200° F. It also happens very conveniently that the electromotive force of the cell is nearly unity, being in fact 1.019 volts.

THE city of Topeka, Kansas, has a municipal electric-lighting plant which cost in the aggregate $55,447.98, and comprises 184 arc-lamps of 2000 nominal candle-power each. A return exhibiting details of cost and results of operation for 38 months has been published, from which it appears that the aggregate hours run was 7622.8 and that 5078 tons of coal costing $13,924.64 were consumed. The entire cost of operating the plant, inclusive of interest on cost at 6 per cent., insurance, and repairs for the above period, was $54,240.95, making the cost per lamp per month $7.75 and per hour 3.86 cents. The cost of coal was almost exactly one-fourth of the total cost of operation. The figures are given in great detail, and the whole is a valuable contribution to the discussion now going on as to the actual cost of electric lighting.

AS an argument in favor of the use of electricity as a motive power for traveling cranes may be cited the crane built by the Yale & Towne Manufacturing Company, at the Columbian Exposition. The Machinery Hall is divided into three bays, each covered by an electric traveling crane, the above-named crane occupying the central bay. The crane has been in active and constant operation day and night, handling the heavy materials and installing exhibits since the middle of December, 1892, and not only has it done its own work in the most thorough and satisfactory manner, but has been engaged in handling the exhibits for the side bays, pending the starting of the cranes covering those portions. The great success with which this powerful crane has done its work is ample demonstration of the value of the use of this new motive power, properly applied to correct design and excellent workmanship, and would seem to conclusively prove that the electric traveling crane is the crane not only of the future but of the present.

MECHANICS

Conducted by Leicester Allen.

THAT splendid material realization of the ever-increasing accumulation of knowledge, science, and mechanical skill, built up by generation after generation of mathematicians, metallurgists, physicists, philosophers, chemists, and mechanicians, the steamship *Campania*, and her scarcely less famous rival the *Paris*, while these words are being penned, are starting on what are destined to be voyages of the most intense interest and importance to naval architects, marine-engine builders, mechanical engineers, and shipbuilders in all lands. This interest and importance does not rest in the fact that one of the ships is owned by an American company while the other is an English rival, though this has some significance with reference to the future of American shipping interests. Both these magnificent ships were built and equipped in foreign shipyards, and neither of them is typical of American marine construction. What these voyages are to indicate is the possibility of speed in transatlantic navigation, of endurance under steam pressure but recently thought practicable, and under increased strains to machinery due to the unprecedented power applied to propulsion. To naval architects the records of these two voyages will supply data to guide them in the modeling of other rivals yet to come; for we have not reached the ultimate, either in modeling ships or in engine-building; and, as has previously been asserted in this Department, there is no doubt that higher speed in ocean navigation than has yet been reached will be attained whenever such speed can be shown to be commercially profitable.

THE event above noted, together with the remarkable maiden voyage made by the *Campania*—the quickest first transatlantic trip ever made by any ocean-steamer—and the magnificent display of warships in the recent great naval parade and review in New York Harbor, have combined to focus public attention upon progress in marine engineering in a very notable manner. And yet most people have as yet but a feeble notion of what one of these great marine structures really means. Such a ship as the *Campania* is a miniature world in the respect that on it may be found something of everything produced by the art of man. Of anything the human race has been able to learn, or to execute, through the ages that have rolled away into the far past, some requisition has been directly or indirectly made to give to the world the steamship of the last decade of the nineteenth century. Nothing, even the magnificent collection of buildings of the World's Columbian Exposition, with innumerable contents collected from all lands, can be more inclusively representative of man and his mastery of natural materials and forces than a modern steamship; particularly a warship, that carries in her hull imprisoned forces which, if unrestrained, could wreck a city as completely as it could be destroyed by an earthquake. In this connection the description of the *Campania* given by a Clyde engineer in the present number of this Magazine may be mentioned as giving in a concise, popular, and readable form a graphic picture of the mechanical structure and machinery of a ship so well built in all parts that the first time she crossed the ocean she could break all records for maiden trips, making the voyage in 6 days, 8 hours, and 34 minutes, at one time achieving a speed of 503 knots in 24 consecutive hours, and in one of her remarkable spurts reaching a speed of 23.5 knots per hour,—a speed never before reached by any steamship.

SINCE the above lines were placed in type, the *Campania* has completed her

voyage, and has exceeded every other record made on a trip from New York to Queenstown,—the time being 5 days, 17 hours, and 42 minutes. Her best daily run was 517 miles. It remains to be seen now whether she will eclipse the best westward trip record, which is that of the *Paris*. If she should succeed in this, it is not to be expected that she will long retain the honor of being the fastest steamship afloat. There are others yet to come after her that will probably cut off more of the time now necessary for a transatlantic passage.

ANENT non-rotative steam pumping engines, Mr. d'Auria, at a meeting of the Engineering Association of the South, held at Nashville, Tenn., on April 13, made some interesting remarks. The speaker argued that, apart from any consideration relating to expansion, the aggregate weight of the reciprocating parts in the Cornish engine is 2.3 times the weight of the load, in the Bull engine equal to the load, and in the Worthington one-tenth the load; though it could be made heavier without restriction; but, with reduction of weight in these three successive types of engines, the rate of steam expansion had also to be reduced, it being possible to use in the Cornish engine four expansions, in the Bull but two, while in the Worthington *simple cylinder* expansion was practically impossible. Mr. d'Auria showed that the piston speed is affected by what he calls "effective weight," this weight being expressed by the sum of the products of each of the reciprocating parts by the square of the velocity of its center of gravity of gyration, expressed in terms of the velocity of the plunger as a unit. In using steam expansively, this force in the first part of the stroke is greater than the load and will perform an excess of work, "accelerative work." According to a law which Mr. d'Auria claims to have discovered, the mean plunger speed during the stroke in a non-rotative pumping engine equals

$$c\sqrt{\frac{\text{accelerative work}}{\text{effective weight}}}$$

the coefficient, c, varying with the variation of the propelling force and in the average equaling about 4 8. By the application of this law it was sought to prove that the Bull engine could have been made lighter and yet have used a higher rate of expansion than the Cornish: that a Worthington engine could have been transformed into a high-duty engine by adding a reciprocating weight, about 7 or 8 per cent. of the load, and moving with a velocity four times greater than that of the plunger. This added reciprocating weight, which constitutes a high-duty attachment, was shown in the form of a liquid column; thus, a direct-acting plunger is attached to an extension of the piston-rod of the pumping-engine and moves in a cylinder of its own; at the ends of this cylinder the ends of a U-shaped pipe are attached, and the cylinder and pipe are filled with liquid. The area of the pipe being less than that of the plunger, the velocity of the liquid column is proportionally greater than that of the piston. Shocks due to excess of energy at the end of the stroke are prevented by passing the liquid around the plunger through small channels uncovered —when the plunger, by this excessive pressure, passes beyond its usual stroke. This feature, as well as an illustration of the law of piston speed, were experimentally shown by a model in which the propelling force was a spring attached to one end of the plunger-rod, the load being represented by a weight pulling at the other; these balanced only at the middle of the stroke; the pull of the spring at the beginning was about twice that of the weight, and at the end only equaled the friction of the working parts. When the apparatus was filled with liquid, the piston made a steadier, longer stroke than when no liquid was used, showing the friction of the liquid to be insignificant. Diameter of the plunger, 3.94 inches; diameter of pipe, 2.06 inches; ratio of their areas, 3.65; weight of moving parts, 61 pounds; weight of water in the pipe, 51.5 pounds; hence the effective weight with the water is $W = 61 + 51.5 \times \overline{3.65}^2 = 747$ pounds, and without the water is only $W = 61$ pounds. The accelerative work in both cases is $Q = 4.84$ foot-pounds, and the

length of stroke 0.46 feet. The velocity was found to be, with the water, 0.383 feet per second and, without the water, 1.33 feet per second. According to Mr. d'Auria's approximate formula,

$$V=4.8\sqrt{\frac{Q}{W}},$$

the velocities equal 0.384 and 1.34 feet per second, respectively, showing close agreement with experiment. Besides, the figures show that the effect of the water in the pipe was to reduce the piston speed to about one-third that without water, and that without appreciable loss by friction.

The above is condensed from a communication obligingly forwarded to the editor by Mr. Walter Kirkpatrick, secretary of the association.

A LIVELY debate on the important subject of the circulation of water in steam-boilers has grown out of a lecture delivered recently by Mr. George H. Babcock, of sectional-water-tube-boiler fame, at the Cornell University. In this debate the principal disputants besides Mr. Babcock as yet have been Mr. Fritz Krauss of Vienna and Mr. John J. Hogan, the latter being an engineer of repute and one who has given much attention to the construction of steam-boilers both for heating and power purposes. Mr. Krauss also is an engineer of creditable attainments. Of Mr. Babcock's ability to discuss a question of this kind it is wholly unnecessary to speak, as for years he has stood at the head of a firm widely known both in the United States and in Europe. Now it has come to pass that Mr. Krauss differs with Mr. Babcock on the questions discussed in the lecture referred to, and Mr. Hogan differs with both Mr. Babcock and Mr. Krauss. The doctors thus disagreeing, one must be cautious in attempting to decide the question in dispute. The debate has been carried on with spirit in the columns of *Power*, and is far too voluminous and technical for even a partial review here. The principal bone of contention appears to be propositions made by Mr. Babcock in his lecture, which are, in substance, that an admixture of steam in water tends to increase its velocity of circulation up to a given limit, this limit being reached when the rising column is all converted into steam, and that the maximum weight of water circulated will be when "the density of the mingled steam and water in the rising column becomes one-half of the solid water in the descending column, which is nearly coincident with the condition of half steam and half water, the weight of the steam being very slight compared to that of water." Mr. Babcock's lecture is notable as probably the first attempt at the systematic investigation of the circulation of water in boilers by the application of mathematical methods to experimental data. Far too little is known of the real state of things in boilers generating steam. On the other hand, Mr. Hogan is known to have devoted much time in the performance of ingenious experiments relating to the subject; and in the April number of *Power* he has described and illustrated quite a series of such experiments, the results of which are opposed to the accuracy of the principles enunciated by Mr. Babcock.

Mr. Krauss attacks Mr. Babcock's propositions on mathematical grounds, while Mr. Hogan, regarding steam bubbles as bodies of gas confined in films of water, and as having expansive force in all directions, maintains that their formation and presence in steam-generating tubes is an obstruction to circulation, and that the circulation of water in a tubular system is always less when steam is forming than when the water is solid. It must be confessed that the experiments adduced by Mr. Hogan as proving this theory, as well as an anomaly in the circulation of water that occurred in a water-tube boiler installed by a firm in New York city, seem convincing that something like what he claims to occur does actually take place in boiler circulation, to-wit: that the presence of steam in tubes, instead of acting together with gravity to increase, acts against gravity to decrease the velocity of the circulating water. But are these experiments conclusive in establishing Mr. Hogan's theory? They were performed in glass tubes of small size, and in such tubes capil-

larity is a considerable force. A bubble that would form in a small tube and fill it would easily detach itself and float up through a larger column. If it were possible to repeat Mr. Hogan's interesting experiments in transparent tubes of a size comparable to those actually used in water-tube boilers, we should probably soon know by actual observation the true inwardness of boiler circulation, which up to the present time has eluded direct observation, and is only inferentially known, if, indeed, it can properly be said to be known at all. Mathematical methods proceeding from experimental data may fail if there be any defect in the data. On the whole, the question of the exact action of water when steam is forming, except in open vessels and in small transparent tubes, is yet unsettled. Many general principles are known, but anomalies occurring in the experience of every steam engineer point clearly to the fact that we are far from complete knowledge. Now that the subject has become a live one, it is to be hoped that the interest aroused in it may not subside till some ingenious experimenter has contrived a way to force nature to reveal her secrets in steam generation, clearly and unmistakably.

"THE battle of the gages" was a phrase familiar to railway-men and to mechanical engineers twenty years ago, when the technical press teemed with discussions upon the relative values of broad and narrow railway gages. Neither the broad gage track, such as the New York and Erie railway made the serious mistake of first adopting, thus incurring an enormous expense for change to the present standard width of track a few years later, nor a gage narrower than the one now used, which also had numerous and strenuous advocates, survived the controversy, with the exception of a few narrow gage tracks used for special purposes and wholly disconnected with any of the great lines. Now a new battle of gages is on, but this time it is wire-gages that are giving rise to contention. Many and loud have been the complaints in the mechanical world that the existing lack of uniformity in wire-gages gives rise to never-ending perplexity and inconvenience. Though the contention has not been confined to the medium of any single journal, there has been, perhaps, more said and well said upon the subject in the *American Machinist* than in other papers among our exchanges. This paper has placed itself in the van of reform in the matter, and has opened its columns widely to communications upon the subject, some of which have shown much ability and a comprehensive grasp of the difficulties that present themselves whenever a radical reform in mechanical methods or appliances is proposed.

There is, perhaps, just at present no question before the mechanical and manufacturing public that might by hasty and ill-considered legislation be made to give greater annoyance than this could. The numerous gages already in use are sufficiently worrying, without the addition of a new one as defective as any of them. The American Society of Mechanical Engineers has taken up the subject and referred it to a committee. Associations of iron and steel workers have urged the adoption of a new table of United States standard gages, and have pushed forward the proposition so energetically that they have got it before a congressional committee. Clearly the legal establishment of a uniform scale, if reasonably free from defects, would be very desirable; but Mr. Oberlin Smith, one of the committee appointed by the American Society of Mechanical Engineers, has criticised the proposed scale with great force in a recent number of the *American Machinist*, showing absurdity after absurdity in it, and calling for concerted action to prevent its being saddled upon the country by hasty, injudicious, and ill-advised legislation. This department has not the space for a résumé of the objections raised by Mr. Smith; but they are very forcible, appealing to common sense in a manner that, it would seem, must inevitably influence the final decision of the question adversely to the proposed new scale.

A GREAT loss to the country as well as to the American Society of Mechanical

Engineers has resulted from the destruction of the records of the society's committee on standard methods of testing. These records were in the office of Mr. Gustavus C. Henning, a member of the committee, when the recent fire occurred in Temple Court building in New York city, a fire that, notwithstanding it broke out on an upper floor of a building hitherto claimed to be fireproof, did much damage to the building and burned up much of the effects of its occupants. The data comprised in the records destroyed were of very great importance, being derived from years of work on the part of Mr. Henning; and their loss will indefinitely delay the completion of a valuable and important work upon which much time and labor have already been expended.

AMONG the new books that have made their appearance this year is one on "Pumping Machinery,"* by Mr. William M. Barr. It is an octavo of 447 pages, printed in clear bold type, on good paper, and profusely illustrated. One of its best features is a copious and well-prepared index, a feature of technical books that too often is not given the attention it ought always to receive. The book is to pumps what Seaton's "Marine Engineering" is to the marine engine, and those familiar with the last named treatise will hardly need a higher recommendation for Mr. Barr's work, which is both theoretical and practical, entering thoroughly into the details of pump construction as well as principles of their action. The discussion of the subject of suction and delivery-pipes contained in Chapter VI. is enough in itself to produce a favorable impression of the entire book, yet, though this chapter is of great practical interest, one turns over into other chapters only to realize the same satisfactory sense that, while the book is extremely thorough, there is nothing superfluous in it. Did space permit a review of this excellent book in this Department, its merits would certainly entitle it to such treatment; but whoever, feeling the need of a thorough and exhaustive work on pumping machinery, accepts the opinion of it here given as a warrant for its purchase is not likely to be disappointed.

**Pumping Machinery.* A Practical Hand-book Relating to the Construction and Management of Steam and Power Pumping Machines By William M. Barr, Member of the American Society of Mechanical Engineers. With upwards of 260 engravings, covering every essential detail in pump construction. Philadelphia: J. B. Lippincott Co. 1893. [Price, $5.]

THE preservation of timber from the assaults of the *Teredo navalis* is said to have been successfully accomplished by a process discovered and subjected to trial at the Gig Harbor lumber mill, Puget Sound. The method employed is said to proceed on an entirely new principle, to-wit: the starvation of these destructive worms rather than their destruction by poison, as has been heretofore attempted. It is claimed by the promoters of the method that the worms penetrate the timber simply for food, of which, in its natural state, wood is a deposit; and that the new process merely unfits timber for the food of the teredo, while, at the same time, the usefulness of the timber remains wholly unimpaired. The details of the process are not given, but an account of some tests of its efficiency is very encouraging, if it is not in any way exaggerated. A solution of some sort is used, by which the nutritive character of the wood is changed so that the worms do not touch it. A stick of timber so treated is alleged to have been sunk in Gig Harbor for more than a year; and, while a stick of the same timber not so treated but tied to the prepared stick was wholly destroyed, the timber that had been treated was not touched. Other tests have been made, the results being reported as similar to that made in Gig Harbor. If all this proves to be true, the inventor of the process has conferred a great benefit upon the human race. It would be hard to estimate the loss in the destruction of timber used for wharfs, docks, etc., annually resulting from attacks of the teredo, which such an invention as is here described might prevent.

ARCHITECTURE.

Conducted by Barr Ferree.

IT is well, now and then, to briefly survey the educational field in architecture, and, June being the month of examinations and commencements, there can be no better opportunity than the present. The education of the architect is clearly the most important part of his career. In this period he learns the elements of what he knows and lays the foundation of his after work. His future monuments, be they good or bad, have their origin in this epoch, and the ideas drilled into him then, the models he then learns to think about and copy after, are the models of his later work. And incidentally they help to make the lives of other people, and even other generations, good and pleasant or uncomfortable and disturbed, according as they are good or bad and he has learned his lesson well or ill. Architectural education in America, as has been so often pointed out in these pages, is rapidly getting into the French rut, which the professors and many others think a very fine and satisfactory rut to be in. Satisfactory or not, it is a rut nevertheless, and we have yet to learn that the wheels of progress can move forward in ruts of any sort. Among the educational forces active in forcing the French exotic upon us the *Architectural Review* of Boston must be counted as a powerful one. Originating as a students' journal in the architectural department of the Massachusetts Institute of Technology, it has labored for the French method with untiring zeal. In looking through the early volumes of its immediate predecessor (the *Technology Architectural Review*) recently, we found the following passage, which is well worth quoting as illustrating the trend of architectural educational thought current in this country. In speaking of the appointment of Professor Chandler to the headship of the department it says (Vol. I. No. 4): "We may hope that the pupils, *instead of being occupied with the design of simple modern and utilitarian buildings* (the every-day work of a modern office), will rather be led to concentrate their studies on proportion, scale, historical precedent, and those principles which underlie all design in every style." The italics are ours, and very wonderful words they are. We do not know whether the author of this sentence is the present editor of the *Review* or not, but its policy is apparently in line with this monstrous utterance.

WE use the word advisedly, with a full sense of its meaning and all that it implies. Architecture is not a theoretical but a practical art. Those who practise it are not dreamy artists intent only on giving form to the products of their imagination. They have other things to do than sit in their offices all day long and think, with a pencil in their hands, putting gorgeous fantasies on paper and going into ecstasies over the result, either with themselves or in their capacity as the corporate members of a mutual admiration society. It pleases many of them to call themselves artists and delegate the practical details to another member of the establishment, but the successful architect, like every other successful business man, must be a sharp, shrewd fellow if the world is not to get the better of him. And so, although the sentence we have quoted very well illustrates the ideas of the Frenchites,—if such a barbaric word may be coined,—it is monstrous because it expresses the elevation of the theoretical over the practical, and deliberately calls for the extinction of practical ordinary every-day work because it is so. Is it any wonder that under the guidance of such authority every-day work is full of blemish? Is it any wonder that our architects cannot design successful business buildings when their training distinctly, deliberately, and openly ignores

the possibility of such problems? Architecture is not an art of the clouds; a very terrible thing happened to the only people we know of who tried to build up to these lofty heights, and very much the same thing is happening to American architecture because the teaching of it is not brought down to the level of the foundation. Young men are drilled in the designing of monumental theaters, of palatial residences, of spacious municipal buildings, of impossible crematories, chapels, cathedrals, churches, casinos, music-halls, and what-nots, all prepared on the most gigantic scale, all erected on sites of unlimited areas, paid for with unnumbered pots of money, and carried into execution with the utmost disregard of the consumption of time and energy. Very fine, is it not, and very thrilling to boot, to be sat down, after three years of this sort of thing, to the designing of a $1200 stable or a $2500 country house? And yet the professors would have it that practical things are not in it. The more fanciful a program is, the more unlikely the conditions, the better it is for study. Is it right? We think the word monstrous a better one to apply to it. It is this neglect of ordinary things that makes our every-day architecture so ordinary and wearisome. For a practical people, intent on practical things, doing things in a practical way and for a practical purpose, we certainly permit our architectural education to be managed on a very singular basis.

THE advocates of the unpractical in arcitecture,—for under this head the *Technology Architectural Review* must be classed,—will find a striking commentary on their system in an article on "The Practical Limiting Conditions in the Design of the Modern Office Building," which Mr. George Hill contributes to the *Architectural Record*. This is one of the most notable contributions to current architectural literature made by any writer in the last few years, and may be profitably read by every professor, every student, every architect, draftsman, real-estate man, and investor, for the author has condensed a vast amount of information in an interesting and accessible way, and supports his principles by a mass of figures based upon much calculation and careful observation. It is quite time, in the present mania for high office buildings, that all concerned in their production should know there are certain practical limitations beyond which the architect cannot advance if they are to be a paying investment. Doubtless the advocates of the unpractical will cry aloud at the thought of financial return influencing any sort of building in any sort of way, but if they will tell us what building has ever been erected that did not have to be paid for in some shape or another we will be obliged to them. Whether they like it or not, the financial profit of high office buildings is the criterion by which they are judged and the success determined. But this is not all. Mr. Hill points out the elements that must be combined in the successful building as (1) ease of access, (2) good light, (3) good service, (4) pleasing environment and approaches, (5) maximum of rentable area consistent with true economy, (6) ease of arrangement to suit tenants, and (7) minimum of cost consistent with true economy. All of these points are treated at considerable length, with ample illustration and comment, and the part they take in making the building a success is clearly determined. An especially valuable feature of this article is the series of tables, prepared by the author, giving, in convenient form, comparative costs for buildings built on the brick or steel systems, carried to different heights, built on various sized lots, and numerous other details of similar practical value. If the *Technology Architectural Review* is a safe guide, such things as this are not fit or proper subjects for the young and tender minds in the architectural schools. Only after they begin to fight for themselves and realize how very little they do know, and how very theoretical most of that is, can they appreciate such solid realities as Mr. Hill serves up to them. Yet we do not think we can be wrong in suggesting that a course of lectures on this subject—and why not by this author?—would be a most valuable

addition to the curriculum of any architectural school. We commend this suggestion to the conductors of our architectural schools.

THE Municipal Art Club, which has recently been organized in New York, has laid out for itself a program of considerable proportions. It proposes to raise a fund, by means of membership dues, for the decorations of public buildings and the providing of works of art for public localities, both through competitions and by means of direct purchase or commission. Organized by painters, who largely predominate in its membership, it marks a new feature in municipal art in this country. In an organization of this sort, in which the majority of the membership must necessarily be laymen, the question of the layman's function is likely to occupy an important place. And in truth it is right that it should, for, admirable as the purposes of the club are, appealing as it does to the best element of New York's cultured population, it is still too much to ask that the men who contribute the bulk of the club's income shall have no right or parcel in its management, or do anything but vote the professional members into office year after year. The question brings up the whole subject of the layman's place in art, his right to his opinions, and his justification in passing on the work of his professional brother. It is an undoubted fact that many laymen are grossly incompetent to criticise any sort of artistic production; but it is likewise unfair to include all outside the sacred pale of art in this miscellaneous category. Art, and especially public art, cannot improve so long as the artists wrap mantles of superiority around themselves and refuse to have more than a speaking acquaintance with laymen. Mutual intercourse is the key to mutual improvement, and the Municipal Art Club has an unrivaled opportunity for helping the cause of the distribution of artistic knowledge by welcoming the laymen to its ranks, not for their dollars alone, but for the help and encouragement each can give the other. Caste distinctions have no place in American civilization, and artists should not jump too heavily upon those who, if they are of no other use in the world at least provide them with the means of making a living.

AT the recent dinner of the Department of Architecture of the Brooklyn Institute one of the members called attention to the fact—amazing to him—that, although the Department was then passing through the trial of a competition, in which many members must necessarily be disappointed, they were sitting down together in friendly converse without a thought of putting poison into each other's cups or otherwise misbehaving themselves. We do not know how extraordinary this self-control may have been for Brooklyn, but certainly it would not be considered out of the way in many other communities. But this remark suggests something more than a commentary upon Brooklyn table manners. Why should rival architects, engaged in a competitive business of any sort, think it an amazing sign of grace to meet their fellows in friendly talk? Every day and every hour business men in all walks of life are doing the same thing, and we quite fail to see any reason why architects, even though we call them artists, should be exempted from this common every-day rule. Whatever architecture may be in theory, it is clearly enough, in this day and generation, a matter of business, and the architect measures his success by the amount of his business, not by the personal gratification he derives from it or by the number of soul-thrills he undergoes annually. It should not, therefore, be necessary for the architect to look upon his fellow-workmen in the light of hated rivals, to think to turn down another street when he sees them passing, or to hint of poison when chance throws them together in a convenient restaurant. But as an offset to this there is the indisputable fact that no other class of business men—call them professionals if that be more acceptable—conduct their work,—labor, occupation, business, art; take your choice, it is the idea, not the word, we are concerned with,—on the competitive system, in which all or a number fight for the

same job, at vast personal expense and very considerable mental worry, which does not a little to deteriorate the architectural standard of the country. Other business men may cut prices, may offer greater inducements in the quality of their goods, in the time and manner of payment, and a host of other legitimate expedients constantly practised by most successful business houses. There is none of this for the poor architect. He may not charge more than a fixed schedule, and, while the quality of his work may be better than that of his neighbor's, it is only by presenting a pretty picture that he is able to suggest the fact. Perhaps, after all, to men doing this sort of thing every day in their lives a suggestion of poison at a friendly banquet may not seem strange. Under the mental strain occasioned by such a method of existence almost anything can be excused and accounted for.

THE World's Columbian Exposition at Chicago is unquestionably the greatest architectural event of the year. Notable in many ways and from many causes, this great exhibition is more notable for its architecture than for any other single element. It marks a new feature in the popularizing of the art and is especially remarkable in showing the vast growth architecture has made among the people of America as compared, for example, with the Philadelphia Centennial Exhibition. The tawdry ugly structures of that show doubtless did considerable good in the way of serving as an example to the managers of the present exhibition of what not to do. This in itself was considerable, but the enormous expenditures of the Columbian Exposition have been largely caused by an attempt to produce an artistic architectural *ensemble*. Every one knows,—and the people of Chicago most of all, perhaps,—that the palatial structures on Lake Michigan were not essential to the success of the exhibition. Desirable as splendid buildings always are in exhibitions of this sort, it is not the buildings themselves that are on exhibition, but their contents. Any building that will safely house the exhibits and permit their display in a satisfactory manner fulfils the end of an exhibition building quite as fully as the most gorgeous structure devised by human hands. But the managers of the World's Columbian Exposition were not satisfied with utilitarian buildings alone. They recognized the value of an artistic group of buildings, and so wisely have they planned that the Chicago Exposition buildings are now the most-talked-of structures on the earth. And the most remarkable part of the enterprise is that some $18,000,000 has been expended in this practical unartistic country of ours for buildings most of which will only be used half a twelve-month. Never in the history of the world was so gigantic an expenditure made for so short a time, and the wonder of it is that it was, most of it, for architecture, the one art of all others we are apt to consider ourselves behind in. No Roman emperor in the plenitude of his power ever conceived so vast a festival as this which is now being celebrated in this land of the people and the free. It marks a new epoch in the evolution of American character and American taste, and above all in American architecture. Surely among the final results of this great enterprise its influence on the future of American architecture must hold the first rank. People who never talked of architecture talk of it now, and the fact that there is such an art—a real art and a true one—will be made manifest to many minds where before the very conception of it was impossible.

APROPOS of the World's Columbian Exposition, what a pity it is it is not more generally called by its full and official title. It has become the custom to speak of it, in many quarters, as the Chicago Fair, a method of nomenclature which has done it positive harm in foreign parts, since until this great enterprise was undertaken the good city of Chicago was not so well known to the inhabitants of the earth and of space generally as it is now. The contemptuous treatment of the fair in its early stages by a large portion of the eastern press likewise helped to make the Exposition seem local among those who have not yet learned to estimate the utterances of

the newspaper press at its true value, if anything closely approximating zero may be said to have a value. But now that the Exposition has fairly opened, this provincialism—in which metropolitan organs were most active—is rapidly disappearing, and even the daily newspapers are beginning to recognize the fact that the Exposition is not Chicagoan at all, but the World's. This however has not prevented poets and other dabblers in architecture from devising names of their own for it which have attained more or less publicity. One of these enterprising folk will be remembered as the editor of a comic paper, who claimed immortality for himself for devising the term "White City" in an architectural study that appeared in *Scribner's Magazine*, and which was much more notable for announcing, for the first time, that Mr. Sullivan's Golden Gateway to his Transportation building was Roman. It is not every day that discoveries like this can be made in current architecture, though it is painful to admit that it has not received the recognition to which it is entitled among architectural experts. But then great discoverers—witness the great Christopher himself—do not always obtain their due reward in their lifetime. Then an estimable lady artist comes out in *Harper's Magazine* with a new name, more poetic, certainly, though not so catchy as the effusion of the comic historian of architecture just referred to. She thinks "Dream City" a more appropriate name for the exhibition than the prosaic practical expressive title chosen by its originators. The suggestion is a little late, unfortunately, but what might not a circulation manager have made out of an offer for a prize for the great show! This may serve as a hint for the next great American exhibition, but meanwhile we think it just as well to designate an exhibition held in honor of Columbus by a title that expresses that fact.

PROFESSOR FREDERICK'S book on architectural rendering in sepia* is an attempt to provide a handbook on a subject that naturally calls for verbal exposition and treatment. Notwithstanding this fundamental difficulty, he has produced a practical work, though perhaps at the expense of a pleasing manner of composition; it suggests, in fact, the running comments of studio or drafting-room work rather than the well-reasoned thoughts of the writer. One might also justifiably find fault with the lack of systematic arrangement in the instructions given, though it may be questioned if a more orderly method is possible in work of this kind. Apart from these drawbacks, however, which would be slight in the hands of an intelligent student, the book is capable of giving much help to the draftsman. The instructions are numerous and cover a wide range of points. Its greatest error unquestionably consists in giving students' work in illustration to students. With but one or two exceptions the drawings are manifestly the work of amateurs and as a rule are disappointing. The book would have gained considerably in value had the illustrations been from a master hand, while some thoroughly good examples of finished drawings are positively necessary in a book of this description. On the whole, it may be commended to those who cannot have the benefits of verbal training, while for those who can its shortcomings can readily be remedied.

**Architectural Rendering in Sepia.* By Frank Forrest Frederick. New York: William T. Comstock. 1892.

INDUSTRIAL CHEMISTRY.

Conducted by Dr. R. A. Witthaus.

IT is curious to note the controversies regarding the relative value of the electric light and of manufactured gas for illuminating purposes which appear in each issue of the journals devoted to these respective industries. But while such controversy is necessarily futile in itself, undoubtedly it is productive of good results on both sides, resulting in the study of shortcomings and, where possible, in the remedy of the same. In Indianapolis the other day the current from a trolley-wire went wandering and descended the hollow iron supporting pole until it made contact with a "dead" gas-main. After burning a hole in this, it continued on along the dead main until it reached a point where this crossed a main carrying gas and here burned a second hole. The gas now escaped through into the dead main, and finally, passing up the pole, was set on fire, the wires were burned, and traffic stopped. On the one hand, of course, this is proof that such a dangerous commodity as gas should not be allowed on the main thoroughfares, while on the other hand it clearly shows that the pressure of a powerful current of the electric fluid is a constant menace to human life. We do not intend to argue whether it was the match or the gunpowder which did the damage, but merely to speak of the relations of these too frequent accidents to chemistry, over that bridge between chemistry and electricity, —namely, electrolysis.

M. P. JOUSSELIN recently presented a paper before the Society of Civil Engineers of Paris in which he discusses the two primary causes of explosions from the combined effects of gas and electricity, the first being by actual contact of pipe and cable and the second by electrolytic action. From this second part of his paper we abstract the following: In Paris the gas-pipes under the sidewalks are covered with calcareous earth and débris consisting mainly of carbonate and sulfate of lime; these salts are decomposed by the action of the electric current, there is an increase of temperature, and carbonic or sulfuric acid is liberated, which, being carried to the pipes, attacks them, forming carbonate or sulfate of lead as the case may be. Thus the substance of the pipes is consumed, a hole is produced, the gas escapes, and eventually an explosion occurs. The same action is observed with iron pipes, the salts of the latter metal being formed instead of the corresponding salts of lead. On June 15, 1892, a series of these explosions occurred in two Edison manholes at the corner of Rue Breda and Rue Nôtre Dame de Lorette. There was much difficulty at first in arriving at a satisfactory explanation of the accident, but the following was that finally adopted. During the previous March there had been snow in Paris, and salt had been used upon the streets. It was concluded that this had found its way into the Edison conduit and had there been electrolyzed, producing chlorin and the metal sodium. This sodium combined with the water present, setting free its hydrogen, which in turn combined with the chlorin from the salt, forming a detonating mixture which was exploded by the electric current. It is but fair to add that M. Jousselin evidently does not himself accept this ingenious explanation, but considers the above explosions to be of gas, which, having penetrated from punctured mains into the manhole, had there three times formed an explosive mixture.

PIERRE GIRON has given an interesting little sketch of the Portland cement industry of Europe, from which we take what follows. The first known cement-factory

in England was built about 1825 at Northfleet, on the Thames. The process then used was crude, and little or no advance was made for a number of years. In 1850 four factories only were engaged in this industry, but since 1860 rapid progress has been made, and the present output is in the neighborhood of 8,300,000 barrels annually. Few improvements have been made in the manufacture, as in England the raw materials, chalk and clay, are obtained in such a state of purity as to render it possible to produce a high grade material with inferior methods. Practically the entire output of the kiln goes into one quality of cement, being graded for the market according to the fineness of grinding. Of late years, however, owing to the competition of the continent, the English cement has been sifted, but, according to M. Giron, still falls far behind the German and French makes in point of fineness. The manufacture of cement was first introduced into Germany in 1852 at Stettin, and from that beginning the industry has steadily and rapidly increased until now there are 60 large Portland cement works, producing about 8,500,000 barrels annually. Having a poor material difficult to handle, the Germans have been compelled to devise and to employ the most progressive methods of manufacture, and for this purpose have organized a public association, the researches and studies of one manufacturer thus benefiting all.

In France the cement industry has advanced more slowly than in Germany or England, amounting at present to an annual output of 1,800,000 barrels. The French cement, however, particularly that manufactured at Boulogne, is of excellent quality and second to none in the world. Russia produces about 900,000 barrels of cement per year, the first works having been built in 1857. Belgium produces 800,000 barrels per year; Sweden and Norway about 505,000 barrels, of which the bulk is from Sweden; Denmark's output is 300,000 barrels per year. The rest of Europe, including Austria, Switzerland, and Italy, has a small output, which is principally what is called natural Portland cement and of no great reputation.

In connection with the above historical sketch of the Portland cement industry of Europe it may be of interest to follow its later history in this country. In 1872 Mr. D. C. Saylor began a series of experiments upon the limestones at Coplay, Pennsylvania, and was so far successful that in 1875 our first Portland cement was put upon the market. The first process, naturally imperfect, was subsequently much improved, and the manufacture is still carried on by the original company. The material used is a natural cement rock containing approximately the proper proportions of lime and clay, pure lime being added when necessary to make the requisite correction. The six works now established at this location in Lehigh county produced in 1891 250,000 barrels, or more than half of the total American output for that year. In 1874 Mr. D. Millen began experiments upon the deposits of shellmarl at South Bend, Indiana, and in 1877 a kiln was built. In 1878 this company supplied the United States government with the cement used in the construction of the Rock Island Arsenal. In 1886 Mr. Millen purchased a bed of marl and clay at Warner's, 12 miles west of Syracuse, New York, selling the works at South Bend to the present company. The Warner's plant recently passed into the hands of a Pennsylvania company and Mr. Millen again removed; this time to Wayland, Steuben County, New York, to take up the cement manufacture there, using deposits in the vicinity. A second large plant was established at Warner's by a Syracuse company. In 1891 the States producing Portland cement, named in the order of their importance, were as follows: Pennsylvania, New York, Ohio, Dakota, Indiana, Colorado, and California. The total production in 1891 was 454,813 barrels, there being 18 mills in operation, and in 1892 525,360 barrels, from 23 mills.

E. BLANC, in *Dingler's Polytechnisches Journal*, describes a process used in making hard bricks in Mongolia. It seems that in the western portion of that country the conditions of climate are so severe as to cause the rapid disintegration of ordi-

nary bricks and even of building stone. The composition of the clay used is not given, but the process is described as follows: a vertical cylindrical kiln is surmounted by a dome, through which is an aperture for the escape of gases. There are also three chimneys inside the furnace opening outward at the height of the dome. During the first three days these chimneys are closed, the central aperture being open, but at the end of that time the fire is allowed to die down, and the dome opening is nearly closed by pieces of moist clay. The small aperture left is covered with moist felt and this with sand, which is kept wet; then the fire is again started, the chimneys being opened, and the process continued with the reversed draught for another period of four days. At the beginning of this second firing the bricks have a light red color, but gradually change to a dark gray. The finished brick is durable, hard, and sonorous, resembling trachyte in appearance. From the same journal we take a note of a new apparatus for measuring the relative hardness of metals and other substances. A beam balance carrying a diamond at one end and so arranged as to permit of carefully measuring the varied pressure exerted, together with a holder for the substance under examination, constitutes in the main the apparatus. The diamond is pointed and conical with an angle of 90°, the width of the scratch made thereby being taken as the gage of the hardness. Previous to the test the substance to be examined is polished, and the surface carefully leveled and smoothed.

AN ingenious German has invented a process for removing the element of smoke from the combustion of coal, and that by an entirely different principle from any of those suggested by others. The tests are said to have been very satisfactory, and contracts have been entered into with several large manufacturing concerns. The coal is first finely powdered by special machinery and is then injected into the furnace by an automatically regulated current of air. The carbon is entirely consumed, there is no smoke, and no ash is precipitated. The fire is under perfect control and can be started or cut off at a moment's notice. Should this process accomplish what is claimed for it, it is indeed valuable.

TAKING advantage of the peculiar properties of boracic, or boric acid, Mr. H. N. Warren has recently devised a new process, or rather an improvement over the old process, for the manufacture of borax. Common salt is subjected to the action of crude boracic acid of commerce, the decomposition aided by superheated steam being effected in large clay retorts of acid-resisting material built with tubulated tops. The retorts are charged with an intimate mixture of ground sodium chlorid and boracic acid. Connected with the neck of the retort is a condenser for the purpose of collecting the hydrochloric acid, which is disengaged in abundance as soon as the heat reaches a low red. The heat is gradually raised and steam introduced through the tubulure until at the termination of the reaction anhydrous borax remains in the retort and a dense pure acid is obtained from the condenser. The anhydrous borax, while still red hot, is ejected into cold water and allowed to remain 48 hours, or until it has passed into a solution, from which it is crystalized and made ready for the market.

IN a late issue of THE ENGINEERING MAGAZINE we reviewed a paper by Mr. D. R. Steuart on the "Flashpoint and Heat of Burning Oils," read before the Glasgow and Scottish Section of the Society of Chemical Industry. The Section at a subsequent meeting discussed Mr. Steuart's paper, and finally appointed a committee to investigate the question fully. The following is the report, which was unanimously adopted as the sense of the Section:

In pursuance of a resolution passed at the meeting held in Edinburgh on December 6 last, your committee appointed the following subcommittee to investigate and report upon the present legal flash-point of mineral oil:—The chairman, Mr. C. A. Fawsitt, Mr. G. Beilby, Mr. John S. Macarthur, Prof. Edmund J. Mills, Mr. Edward C. C. Stanford, and Mr. Daniel R

Steuart. At a meeting of committee held this day the sub-committee submitted the following report:

Your sub-committee is of opinion that:

1. The present legal flash-point (*i. e.*, 73° F.) for mineral burning oil is too low, and therefore, under ordinary circumstances, dangerous.

2. The Government Abel-test is perfectly satisfactory for determining the lowest temperature at which inflammable vapors are evolved.

3. 100° F by this test should be the minimum legal standard.

4. The Government Abel-test is not invariably employed to determine the flash-point, as is evidenced by the fact that burning oils flashing at from 73° F to 86° F. Abel-test are constantly imported and sold, bearing brands of from 120° F. to 150° F., and thereby the public are misled.

5. All burning oil imported in this country should have the Abel-test plainly branded on the cask.

6. Many fatal accidents have occurred from the use of this inflammable oil, and as a measure of precaution so-called "safety lamps" constructed of metal have been recommended. Unless the oil itself is safe, a new source of danger is introduced by "safety lamps."

Your committee have unanimously adopted the above report, and have now the honor to lay it before you.

THE *Revue de Chemie Industrielle* describes the electrolytic preparation of chloroform as follows: The apparatus consists of a retort of enameled iron having a double bottom, by which means it can be steam heated. A condenser is provided for the collection of the vapors of water and chloroform which pass over. The electrodes originally were of lead, but have recently been replaced by carbon and copper; the former, the anode, consisting of carbon rods inserted upon a revolving central shaft, the whole acting as a stirrer. The cathode consists of a copper cylinder. Three hundred litres of a 20 per cent. solution of sodium chlorid are charged into the retort through a tube. About 60 kilogrammes of acetone are treated at one charge, the operation lasting two hours. The condensed distillate separates into two layers, the upper of water containing a little acetone which is saved and utilized in dissolving the salt for succeeding operations; the lower layer is of pure chloroform, containing none of the chlorinated products so common in the other processes. The yield of chloroform amounts to 190 per cent. of the weight of acetone used.

SODIUM silicate is a substance not widely known outside of manufacturing circles, and yet it finds so many important uses that a word regarding it may not be out of place. The *Oil, Paint and Drug Reporter* (New York) gives a few words on its industrial uses, and from the note there given we make this abstract. The principal use to which it is put is, of course, in the manufacture of cheap soaps, but on account of its properties it is very suitable for use either by itself or in connection with other detergent materials for cleansing articles when the action of caustic soda is too keen and the action of the carbonate not powerful enough. Several of the continental railway companies are using silicate to recover their dirty cotton waste, being able thereby to recover the same no less than 12 times, whereas by using caustic soda this can be accomplished only two or three times at the most. With the silicate the strength of the vegetable fibre is apparently not injured. The silicate has also been used very successfully as a substitute for caustic soda in the manufacture of paper, especially in the bleaching of jute and hemp waste, and in the sizing and waterproofing of paper. It is an excellent fixing agent for alumina and other mordants on cotton, and is said to be unequaled as a sizing for cotton thread in preparing stock for the loom. It has been used for some 30 years for the purpose of rendering textile fabrics incombustible. Large quantities are consumed in the manufacture of artificial stones, of enamels and paints, the so-called silicated paints containing silicate of soda as a principal ingredient. The silicate is also used in construction for rendering timber fire-proof and walls water-tight, or air-tight, for soaking bricks to prevent diffusion, for painting steam-pipes, and, mixed with asbestos, as a non-conducting material for jacketed pans, retorts, etc. It may be used alone or in

connection with other materials as a cement for stone, glass, porcelain, marble, etc., and for attaching labels to metal surfaces. Certain cements owe their hardening property to the silicate of soda contained. The silicate is moreover important as the source from which pure hydrated silica is prepared.

THE presence of arsenic in glycerin destined for pharmaceutical purposes has excited considerable comment during the past year, and hence a paper by Dr. J. Lewkowitsch treating of the fact from a manufacturer's point of view is highly interesting. The arsenic in the glycerin owes its existence to the arsenic contained in the reagents used in the manufacture, and cannot be removed by distillation as has been stated. The fact of the matter is that all glycerin intended for pharmaceutical purposes is distilled and double distilled. Dr. Lewkowitsch, experimenting with the substance formed when arsenious acid is dissolved in glycerin, namely the arsenious ether of glycerol, As O_3 (C_3 H_5,) found that at 250° C. it is decomposed and hydrogen arsenid with other volatile arsenious compounds is distilled over. It is quite evident therefore that any arsenic contained in glycerin will distil along with it. According to Dr. Lewkowitsch, there is no known process for freeing glycerin from its contained arsenic. The only way then to obtain the pure product is to use only such reagents in its manufacture as do not contain arsenic. This is accomplished where the fats are hydrolized by means of water, whether in the liquid state under high pressure or as superheated steam. The lime process which is still practised, especially in the smaller works, should also yield an arsenic free product, while on the other hand glycerin from works using sulfuric acid saponification will contain arsenic, unless, as is unlikely, such acid should be free from the metal. Ten samples of glycerin were examined with the object of ascertaining whether pure glycerin was on the market. Three of these samples would have to be rejected, four contained very small traces, while three only were absolutely free from arsenic. There is still another source of glycerin, the so-called soap-lye glycerin, produced in the saponification of fats on a large scale. This particular source of glycerin has however been looked upon with disfavor, though not altogether justly, as Dr. Lewkowitsch proves.

Arsenic, though the principal impurity, is not the only one to be found in "chemically pure" glycerin, organic impurity as fatty acids, etc., or as "polyglycerols," being generally if not always present. Evaporation of a sample in a platinum dish at 160° C. affords a simple test for this residue and for the ash. Fatty acids, as butyric acid, etc., and other organic impurities are readily detected by means of the ammoniacal silver nitrate test, though this is more rigorous than may be necessary.

BY means of the electric furnace described in the last issue of THE ENGINEERING MAGAZINE, M. Moissan has obtained some interesting results in the reduction to the metal of some of the most refractory oxids. Uranium was obtained by subjecting a mixture of uranic oxid, U O_3, and of the green oxid, U_2 O, with a little powdered charcoal to a current of 450 amperes at 60 volts. An ingot of metal was produced consisting of about 90 per cent. uranium and 10 per cent. carbon. This carbid slowly decomposes water at ordinary temperatures and has a melting point much higher than that of platinum.

By exposing a mixture of pure protoxid of manganese and carbon to 300 amperes at 60 volts, in 5 or 6 minutes an ingot of manganese carbid weighing 100–120 grammes is obtained. The carbid thus produced contains 89 per cent. of metallic manganese, but by using an excess of the oxid the percentage of carbon is reduced and the metallic manganese increased to 95 per cent. A mixture of sesquioxid of chromium and carbon is reduced in the same manner, a metallic ingot adherent to the crucible and containing about 89 per cent. of the metal being obtained. Natural chromium can be reduced as the oxid, and by repeated treatment a practically pure chromium produced.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

IT is not the function of this Department to expose individual mining frauds, or to interfere between dissatisfied shareholders and the "control" (that is, the officers and the "inside" owners) of mining companies. If the broad principles of technical mining and of mining financiering are presented, however imperfectly, that is about all that can be expected in such a publication as THE ENGINEERING MAGAZINE. But frequently letters are received asking for information and advice as to particular instances. These are answered by letter so far as our knowledge permits, but cannot be discussed in these columns, for want of space,—to say nothing of want of interest to most readers. Still it may be well to offer, once for all, some general suggestions in regard to cases of the kind; and as an exception, and also by way of text, the following extracts are quoted from a sample letter out of the many lately received:

. . . Being a regular subscriber to THE ENGINEERING MAGAZINE, I take the liberty of writing you for information. There are quite a number of citizens of ——— and myself, who have been led into a mining enterprise, and the more I can find out about it the more it looks like a "fake" or an intended squeeze-out. What I want to know is what is the proper course to pursue in order to bring the officers of a mining company to proper terms. If the company should turn out to be a pure "fake," is there no lawful means of redress? If money can bring the [expletives] to justice and do legitimate mining a good turn, then we can easily and gladly furnish what is required. The company made great claims, and no doubt false ones, in their communications with stockholders. The mine is the ——— of ———, office in ———. Now, they may be all right; but from present information all is wrong. What course would you recommend the stockholders in the East and in ——— to pursue? . . .

In the present instance we have no personal knowledge either as to the merits of the property or the character of the management, only having noticed that there are some ugly rumors afloat. Not knowing anything positive as to the right or wrong of the controversy between the dissatisfied shareholders and officers, the advice given is: First, ascertain definitely whether there are reasonable grounds for complaint. Hear both sides. Get the commercial rating of the men accused. Find out what the local opinion is in the district where the mine is located. If the opposition seems to have a good case and the trouble continues, the dissatisfied shareholders should put themselves in communication with each other, with a view to concerted action. This can be done by advertisement or correspondence in a prominent mining paper, calling a meeting to exchange opinions, ascertain facts, estimate strength, and decide what, if any, steps should be taken. If the opposition finds that it holds a controlling interest in the stock, remedial measures might be taken without going to law, by deposing the incumbent officers and assuming the management and responsibility of the company's affairs. The courts have ruled that shareholders have a right to examine the books of corporations. It has also been held that shareholders may enter and examine to their own satisfaction a mine they are part owners in. Whether they may send in a professional expert, not himself interested, is debatable. But a representative committee of shareholders could be authorized to make both examinations (of books and mine). A case having been made out, the property having been shown to be worth fighting for, so that it would not be throwing good money after bad, prosecution under the civil code would be next in order, provided the dissatisfied shareholders were willing and able to go to the expense and delays of somewhat dubious litigation.

Much depends upon the laws under which the company has been incorporated, which are often not those of the State in which the mine is situated. These laws vary greatly in respect to the amount of protection afforded to shareholders. For example, in some States assessment notices have to be served personally and the delinquent sales made within the State, on further service of notice. In other States the charter laws are so lax that a man does not know whether he owns his stock or not (legally speaking), and if it stands in the name of a trustee he has to get it transferred before he can vote it. It requires experienced mining lawyers to unravel the mysteries of mining and corporate laws. At the bottom, the laws and the courts mean well enough; but it is expensive to reach the bottom. Suits in equity are especially uncertain.

To be perfectly frank, here is the moral: Small investors in mining schemes, who accept the representations of prospectuses and advertisements as gospel, who expect to become millionaires at a jump by puting in a few dollars or hundreds, who do not take the precaution of finding out *beforehand* what they are going into, do not deserve much sympathy. Many of them would buy "green goods" if properly approached. The heavy investors generally have the advantage of impartial expert advice, and can at all events protect themselves in a measure. The little minnows have small chance, and it is to catch them, not the big fish, that fraudulent mining schemes are put forth.

THE relatively depressed condition of silver-mining has deflected the attention of investors toward mining for gold, and just now gold-producing properties are in especial favor with European capitalists. The English investments in the Transvaal gold-fields have been largely increased during the past year, while French syndicates have acquired important holdings in American gold-mines and are considering others. A similar feeling has prevailed among Eastern capitalists in this country, so that it has been much easier to raise capital for the prosecution of gold-mining than for some time past. The demand for this class of properties has been stimulated rather than satisfied by the creditable showing of some of the recently-opened districts in the Rocky Mountain region. Miners, too, are turning their attention in the same direction, and several incipient "rushes" to new gold-fields, brought about by slight evidences of value, have been the result. The shutting down of a number of large silver-mines and the lessened activity in others, by throwing many men out of employment, are adding to the army of prospectors, most of whom will give their special attention to the search for gold. The older steady-going gold-quartz districts keep on the even tenor of their way, with about the same, or perhaps a slightly increased, output, while a considerable addition to the gold production will be made from those hydraulic mines in California, so long closed by the débris legislation, where resumption of work will be permitted under the new system. In short, everything points to an improved position of the gold-mining industry of the United States.

IN a series of letters to the *Iron Trade Review* (Cleveland) Richard A. Parker presents some strong arguments and figures in support of a proposition long studied and advocated by him,—the establishment of a great iron-smelting and iron- and steel-manufacturing industry on Lake Superior, with especial reference to Marquette as a center. Mr. Parker's plan is to bring Connellsville (or possibly New river) coal to the seat of the iron-ore producing districts, and to coke it on the spot, as has been done at West Superior and Duluth. The yield of coke per ton of coal is somewhat less on the lake than in the coal and coke region of Pennsylvania, being 62 to 64 per cent. as against 65 or 66 per cent., or perhaps a difference of 3 to 5 per cent., owing to deterioration of the coal; but it is agreed that this loss, slight on account of the dryness of the climate, is more than offset by advantages of local coke-making at the iron works. Mr. Parker calls attention to the economies gained by the waste heat (not necessarily the waste

gases) of the coke ovens for steam-making and the utilization of by-products, and points to European practice and American experiment in proof. He argues that, if good coke can be made at the lake for $5.50 per ton (the detailed estimates footing up less than $5), with cheap, pure, and varied ores at hand, flux near by, and a coking plant operated in connection with furnace and mill, the outlook is very promising. According to Mr. Parker's calculations, which appear to be conservative (and in a later communication to this department he states that his anxiety to be on the safe side has led him to adopt figures rather too high), coke iron ought to be made at Marquette cheaper than at Chicago by a difference of about $1.45 per ton. So much for the question of assembling the material and cost of manufacture. The next point, after the vital one, as Mr. Birkinbine pointed out in his admirably judicial paper on "Locations for the Pig-Iron Industry" in the March number of this Magazine, is that of transportation, freight rates, and market. Into this phase of the matter Mr. Parker enters with an array of statistics, which he considers show convincingly that the growing consumption of iron products in the Northwest demands a supply center on the Lake, say at Marquette. It is impossible to fairly present Mr. Parker's argument in a condensed shape, but it is well worth consideration, in its original form of publication, by furnacemen and the iron trade, and has attracted wide attention, with some opposition, but generally favorable comment by the technical press.

IT is often important that the grade of adits and main levels should be conformed as nearly as possible to theoretical perfection. This is especially true in two cases: (1) where great quantities are to be handled, as in coal mines and in some kinds of metal mines, and (2) in very long adits. In the first instance it is a question of economy in haulage; in the latter, a question of saving all the grade possible, in order that the heading may be at the greatest available depth, and it is evident that the inches of rise per hundred feet count up fast when the adit is to be a mile or perhaps four or five miles long. In determining the most advantageous grade, another consideration has to be taken into account, —that of drainage. As to haulage that grade is theoretically best on which equal power is required to move the loaded cars down hill and the empties up hill; and in practice, since the track can never be kept perfectly true, it is customary to favor the loaded cars. In André's Mine Engineering the rule given is 1:111; but for ordinary short-distance work it is common to choose a grade of 1:100, and sometimes steeper, which may answer well enough for small mines.

Mr. Richard Lewis, of Carbonado, Washington, has lately reopened the subject, and has recorded some new experiments with real mine cars on actual grades, a method more satisfactory than mathematical discussion where the factors are so irregular. He finds that, with good track and well-oiled mine cars, lighter grades can be adopted than those usual, and recommends 0.42 per cent., which is 5 inches per 100 feet or ½ inch per 10 feet. Even this leaves a margin above the calculated grade of equal resistance (0.32:100 or 1:314) for cars of the weight and at the speed taken in the experiments, allowing for ill-conditioned road, stiff cars, and lower speeds. As to drainage, it depends very much upon the smoothness and regularity of the channel. A boarded drain, laid true, if of sufficient size, will carry all the water a mine will make, on the grade recommended by Mr. Lewis; while, as is well known from experience with unlined ditches in hydraulic mining, it is quite possible to kill a grade several times steeper by breaking it up into jogs.

WHEN the Chicago Exposition was opened at the beginning of last month, the mining department was found to be especially backward and incomplete. The building itself had been finished eight months previously, and had long been ready for the installation of exhibits. The blame for the unsatisfactory state of progress is ascribed to the want of punctuality on the part of exhibitors in forwarding their collections; and it was remarked that the

nearby American States were more dilatory than foreign exhibitors at great distances, which seems to indicate poor management on the part of local organizations and lack of initiative in the general management. It is expected that by the time this number of the ENGINEERING MAGAZINE reaches its readers the mineral exhibit will be in presentable shape.

SPEAKING of hydraulic ditches and their grades recalls to mind a remarkable, if not wholly original, method of laying out a ditch line of this kind by an ultra practical man who scorned leveling instruments. He had no use for levels and rods and pegs, or even the makeshift implements of the miner; so he began at the proposed upper end of the line and scraped a slight trace in the ground where the water would first follow him down, insisting, to the amusement of the bystanders who were watching the proceedings, that this was the natural and safest way of establishing a grade. Now, the reason why a small drain underground in a mine will not always carry water on low theoretical grades, but leaves the floor of a drift or tunnel spotted with bogs and puddles, is the same that was discovered by our amateur ditch surveyor, who found himself consuming the fall at an alarming rate and running out a grade which, on the scale of a full-sized ditch, would create a young torrent and at the same time come out about the level of the natural mountain stream tapped and far below where the water was wanted. These small unlined channels in natural soil and rock cannot be made and kept true; the frequent jogs kill the grade, and the irregularities of the sides and bottoms defy formulæ for friction and negosity.

THE by-products of iron-manufacture formed the subject of a recent lecture by Mr. Thomas Turner, who described the various methods of utilizing waste gases, etc. At some of the works tar is extracted from the gas when hot, and ammonia when being scrubbed, and what remains serves to fire the boilers. The furnacemen, therefore, instead of being the enemy of the agriculturists, as formerly, interfere but slightly with the purity of the air, and supply valuable manures, disinfectants, etc. Basic slags are also now being used for road metal, and bricks, cement, etc., are made of it. Large quantities are also used in the work of reclaiming land. Besides this, the production of slag wool gives a valuable article for packing purposes. Tap cinder is now found to produce a cast iron not of special purity, but suitable for many purposes, and the hot air from the puddling furnaces is frequently used to fire a boiler instead of being wasted as formerly. In the Bessemer process phosphate of lime is extracted, and found to be a valuable recuperative fertilizer.

MR. E. O. LEECH, the Director of the Mint, has prepared a report on the production of the precious metals, covering the calendar year 1892. The value of the gold product from the mines of the United States was approximately $33,000,000, about corresponding to the average product of recent years, being slightly less than the product in 1891 and somewhat larger than the product of the two prior years. The product of silver from our own mines is placed at 58,000,000 ounces, of the commercial value, at the average price of silver during the year, of $50,750,000 and of the coining value, in silver dollars, of $74,989,900. This is a falling off of 330,000 ounces from the product of the preceding year. The Director reports that there was a diminished silver product in each producing State and territory of the United States, except in Montana and Colorado, the two large silver-producing sections.

JUDGE BISSELL, of the superior court, in Colorado, has made a ruling in the matter of expert testimony in trials, which will have a deterrent effect upon the present system of employing *ex parte* expert testimony in mining title cases. The decision was made in the case of a physician's account for $25 a day for testimony in a murder case, but it will serve as a precedent in the case of mining engineers and other experts as well. Judge Bissell holds that, even if the lower court should order a greater allowance, the regular fee at

$1.50 a day is all that experts can get, and, if these witnesses are to have more, the legislature will have to take action first.

THE old Chile roller mill has been modernized and much improved in mechanical details, retaining the same principle but increasing the capacity and being under better control. The new form is known as the Bryan mill. It is made in San Francisco and is being extensively introduced into Mexico. For convenience of transportation in the mountains it is built in sections. It is said to be a good amalgamator and cheap to transport and erect. The primitive arastra, the starting point and prototype of the Chile mill, the grinding-pan, and all similar machines, does excellent work in a slow way; and several forms of its later and more highly developed progeny are still among our most useful machines, though their sphere is limited as compared with that of stamps.

AT Anniston, Ala., may be seen a noteworthy system of rapidly mining soft iron ore on a very large scale by means of steam shovels. In places the working-face of the deposit has been cut so deep as to preclude the use of the shovel, but it is the purpose of the Woodstock company to mine the whole hill clear of everything down to the level of the present cut, taking all clay and rocks heretofore left in the banks. A large ore-washing plant handles the product.

THE great number of new chemical and metallurgical processes which are constantly being introduced, the commercial success of which must depend almost wholly upon the supply of large amounts of motive power at low cost, seem to indicate that the new city growing up at Niagara Falls may become not only the seat of many large manufacturing plants of types already familiar, but also of important new industries as yet unthought of.

THE production of pyrites in the United States has increased from 13,440 tons in 1882 (the first year for which statistics are quoted) to upwards of 100,000 tons annually. These figures refer only to the amount mined for making sulphuric acid. There are, besides, very large quantities mined and concentrated in the Far West as gold and silver ores, and in their treatment the sulphur contained is generally regarded as merely a nuisance to be gotten rid of, as is done by preliminary roasting before feeding into the lead-smelting furnaces. A new iron matte-smelting process utilizes raw pyrites, and chlorination disposes of them also; but all the time there is a valuable element going to waste. It is true that the pyrites mined in the West does not make a good commercial acid as a rule, on account of impurities such as arsenic. But it looks as though there should be some way of treating the sulphuret concentrates obtained from gold mills, and the occasional massive pyrite ores which would not need concentration, by a process that would economically yield, as a by-product only, sulphuric acid good enough for certain metallurgical and other uses where a cheap acid is needed. The residues, as now, would be in demand as flux, and the precious-metal contents recovered in the usual manner.

THE latest report of the Texas Geological Survey gives an interesting and conservative account of the lignite deposits of that State so far as explored, and throws light on questions brought up by investments in those fields. Not much mining has yet been done, but, so far as it goes and so far as trial borings have been made, the beds seem to be unusually regular and reliable, while the quality of the coal is good, considered as a lignite. Mining should be very cheap, as the beds are so near the surface and so free from water. As in other cases in the Western lignite areas, the utilization of these resources will increase with the local demand as population increases.

SOME doubt is expressed as to the reliability of the experiments of Dr. Seger, the German ceramic technologist, which appear to show that quartz is appreciably volatile under conditions of not extraordinary temperature, as in the Deville furnace. The reported results are quite

startling. If confirmed by further research, they may possibly offer a clue to certain phenomena in the smelting of metals in which silicon plays a part, and thus lead to modifications in the metallurgy of iron, aluminum, and other metals. It should be a very simple matter to repeat the experiments under precautions, and thus settle any uncertainty as to the main question. There is no inherent impossibility about it, or any greater improbability than in plenty of other recent discoveries of the same order.

ACCORDING to Mr. John Fulton, who has been contributing an admirable series of papers on coke and coke-making to the *Colliery Engineer* (Scranton), there are four prime characteristics to be considered in judging of the value of coke for use in the iron blast-furnace. These are: (1) hardness, to support the burden of the furnace; (2) full development of cell-structure, so as to expose the largest surface to the blast and insure rapid combustion and high heat; (3) purity, for obvious reasons connected with the quality of the product and the avoidance of too much inert matter to be slagged off; and (4) uniformity in quality. While the requirements for iron-smelting are very exacting, in lead-smelting (by which the greater part of the silver is now obtained), coke of much less strength, less calorific power, and less purity can be successfully utilized. Of course the lead smelters prefer a good coke; but it is fortunate that they can manage with what would be rated as inferior qualities in the iron-making districts, and thus utilize a cheaper and nearer fuel than would otherwise be available.

MONTANA'S silver statue of Justice, for the Columbian Exposition, was successfully cast at the works of the Chicago Bronze Co., and is now on exhibition. It is of life size, and is believed to be the largest silver casting ever made. The metal used, 1600 pounds, is all from the ores of Montana mines. Aspen, Colorado, also has erected a "silver queen" as a part of its exhibit, in which over $20,000 worth of silver, gold, and ore were used.

THE electric furnace has been applied by M. Moissan in the reduction of uranium from its ores. Using it at a temperature of 3000° C., a 250-gram ingot has been made in ten minutes.

RUTHENIUM is one of the rarer metals, and has hitherto been quoted in New York at $5.50 per gram. M. Troost, the eminent French chemist, has recently obtained an ingot weighing 20 kilos., the largest quantity yet made. The method of separation and reduction is not stated, but the source was crude platinum sand.

FOR about a year efforts have been made to open a market in Europe for anthracite coal. The European agent of the Philadelphia & Reading Coal and Iron Co. has reported that the trial shipments sent to points in Germany and Italy have made a favorable impression, although it was found necessary to also ship stoves designed to burn hard coal before the experiment could be begun. It seems reasonable to expect that a considerable demand might be created there for domestic use, when the character of the coal becomes better understood. Freight rates would probably not be prohibitory in many continental markets.

AMERICAN capitalists have bought asphaltum deposits in the State of Tamaulipas, Mexico. Valuable discoveries of bituminous minerals and oil are reported to have been made in southern Mexico.

THERE was a marked decrease in the production of pig iron and steel in Great Britain in 1892, as compared with 1891 and 1890. The make of pig iron was 6,616,890 long tons, against 7,228,496 tons in 1891 and 7,875,130 tons in 1890; while the steel output has declined proportionally.

THE TECHNICAL INDEX.

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THIS publication has been aptly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that within a few minutes an active man can learn of everything that has been published during the month in relation to his special lines of investigation. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential difference,—namely, that in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

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[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. w=words.]

THE AMERICAN PRESS.

A .....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An....American Analyst. *f.* $1 per year. N. Y.
A Ar.....American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B M...Architect, Builder, and Manufacturer. *m.* $1.50. Kansas City, Mo.
A CJ....Am. Chemical Journal. *b-m.* $4. Baltimore.
A D.... ..American Druggist. *m.* $1.50. New York.
A E .....Architectural Era. *m.* $3. N. Y.
A E R J..American Engineer and Railroad Journal. *m.* $3. New York.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2 per year. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..Journal of Railway Appliances. *m.* $2 per year. New York.
A M.....American Machinist. *w.* $3. New York.
A M & I W.American Manufacturer and Iron World. *w.* $4 per year. Pittsburg.
Am A....American Agriculturist. *m.* $1.50. N.Y.
Am G....American Gardening. *m.* $1. N. Y.
A M M...American Mechanics. *m.* $1. Minneapolis.
Am M....American Miller. *m.* $2. Chicago.
Am S....American Shipbuilder. *w.* $2. N. Y.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3 per year. Washington.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50.
B & D...The Builder and Decorator. *m.* $2. Minneapolis.
B G S .. Bulletin of the American Geographical Society. *q.* $5. N. Y.
B I S.....Bulletin of American Iron and Steel Association. *w.* $4. Phila.
B J C....Boston Journal of Commerce. *w.* $3 per year. Boston.
B P .....Bulletin of Pharmacy. *m.* $1. Detroit.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C.....Compass. *m.* $1 per year. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A .. Canadian Architect. *m.* $2. Toronto.
C & B... Carpentry and Building. *m.* $1. New York.
C B T....Builder and Trader. *w.* $2. Chicago.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N... Canadian Electrical News. *m.* $1 per year. Toronto.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4 per year. N. Y.
Cos..... Cosmopolitan. *m.* $3 per year. New York.
D E.....Domestic Engineering. *m.* $1. Chicago.
D J... ..Drainage Journal. *m.* $1. Indianapolis.
D Jour. .Druggists' Journal. *m.* $1. Chicago.
E A.....Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3 per year. N. Y.
E I.....Electrical Industries. *m.* $3. Chicago.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Engineering and Mining Journal. *w.* $4 per year. New York.
E N.....Engineering News. *w.* $5 per year. N. Y.
Eng .....Engineer. *s-m.* $2 per year. New York.
E N Y....Electricity. *w.* $2.50. N. Y.
E P D....Electrical Progress and Development. $2. Boston.
E R.....Engineering Record. *w.* $5. N. Y.
E & R ...Electricity and Railroading. *m.* $1 per year. Boston.
E R N Y..Electrical Review. *w.* $3 per year. N. Y.
E S W P...Proceedings of Engineers' Society of W. Penn. *m.* $7. Pittsburgh.
E W.....Electrical World. *w.* $3 per year. N. Y.
F .....Forum. *m.* $5 per year. New York.
F D.....The Foundry. *m.* $1. Detroit.
F W.....Fire and Water. *w.* $3 per year. N. Y.
G & F....Garden and Forest. *w.* $4 per year. N.Y.
G G M...Goldthwaite's Geographical Magazine. *m.* $2 per year. N. Y.
G R.....Good Roads. *m.* $2 per year. N. Y.
I A.....Inland Architect. *m.* $5 per year. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age *w.* $4.50. N. Y.
I I G....The Iron Industry Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3 per year. N. Y.
I S F.....Industry. *m.* $2 per year. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A.....Journal of Architecture. *m.* $2. Phila.
J A C S..Journal of the American Chemical Society. *m.* $5 per year. N. Y.

J A E S. Journal of the Association of Engineering Societies. *m.* $3 per year. Chicago.
J F I.....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
J M S I. Journal of the Military Service Institution. *b-m.* $4 per year. Governor's Island, N. Y. H.
J N E W. Journal of the N. E. Waterworks Association. *q.* $2. New London, Conn.
J P E.....Journal of Political Economy. *q.* $3. Chicago.
J U S A. Journal of the United States Artillery. *q.* $2.50. Fort Monroe, Va.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L M.....Leather Manufacturer. *m.* $3. N. Y.
L Mag. Lippincott's Magazine. *m.* $3. Phila.
L P.....Louisiana Planter. *w.* $3. New Orleans.
M & B. Manufacturer and Builder. *m.* $1.50. N. Y.
M & El. Mechanic and Electrician. *w.* $2 per year. St. Louis.
Met W. Metal Worker. *w.* $2 per year. N. Y.
M G.....Manufacturer's Gazette. *w.* $2.50. Boston.
Min.....Minerals. *m.* $1 per year. N. Y.
M I T. Mining Industry and Tradesman. *w.* $3 per year. Denver.
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M Rec. The Marine Record. *w.* $2. Cleveland.
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M S R. Mining and Scientific Review. *w.* $2 per year. Denver.
N A R. North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N B D. Northwestern Builder and Decorator. *m.* $2. Minneapolis.
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N M. ...Northwestern Mechanic. *m.* $1. Minneapolis.
N P R. National Popular Review. *m.* $2.50. Chicago.
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P.....Paving and Municipal Engineering. *m.* $2 per year. Indianapolis.
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*11858. Fire-Risks in Electric Insulation. F. A. C. Perrine (E Mag-June) 3000 w.

11984. The Alternating Current Plant at Clermont-Ferrand. Ill. (E N Y-April 12.) 900 w.

*11992. The Manufacture of Arc-Lamp Carbons. Editorial (E P-April 1.) 600 w.

12010. The Incandescent Lamp Situation. F. S. Terry (E W-April 15.) 1500 w.

12011. Municipal Electric Plant in Berne, Switzerland (E W-April 15.) 1400 w.

12016. An Interesting Point. A. B. Upham (E W-April 15.) 500 w.

12017. The Ball System of Electric Lighting. Ill. (E A-April 15.) 2000 w,

*12108. A Secondary Standard for Arc-Light-Photometry. Ill. (El-April 7.) 1850 w.

*12121. The Day Load. Editorial (E R L-April 7.) 1000 w.

*12123. Arc Lamps v. Large Incandescent Lamps for Street Lighting. Sydney F. Walker (E R L-April 7.) 1700 w.

*12124. Joint-Boxes on Under-ground Networks. Ill. (E R L-April 7.) 3000 w.

*12134. The Incandescent Illumination at the World's Fair. Ill. R. H. Pierce (W F E E-April.) 2000 w.

*12137. Underground Electric Mains in Paris. Ill. (E E L-April 7.) 1300 w.

12174. The New Sunbeam Incandescent Lamp. Ill. (E E N Y-April 19.) 750 w.

12175. Recent Improvements in Stopper Lamps—The Benjamin and the Green. Ill. (E E N Y-April 19.) 650 w.

12186. First Annual Report of the General Electric Company (E A-April 22.) 3000 w.

12188. Early History of the Manufacture of the Goebel Lamp. Ill. C. F. Dunderdale (E R N Y-April 22.) 1250 w.

12189 The Columbia Lamp Case. Ill. (E R N Y-April 22.) 1300 w.

12229. A. S. Terry on the Lamp Question (E W-April 22.) 1360 w.

12233. The Central Station of the Akron General Electric Company. Ill. (E W-April 22.) 1600 w.

12287. Columbia Company Wins—Edison Company Refused an Injunction by Judge Hallett (W E-April 22.) 1650 w.

*12348. A Cable Rupture. Ill. Harris J. Ryan (S J E-April.) 1700 w.

12355. The Stanley-Kelly Two-Phase Alternating Motor. Ill. (E E N Y-April 26.) 2500 w.

12357. Paper Insulated Wire and Its Manufacture. Ill. (E E N Y-April 26.) 950 w.

12358. Gas Glow Burners vs. Giessler Tube Light (E R N Y-April 29.) 800 w.

12361. Effect of Hallett's Decision (E W-April 29.) 2100 w.

12376. Incandescent Lamp Patents (E N-April 27.) 600 w.

*12426. Some Economic Points in Connection with Electricity Supply. Gisbert Kopp (J S A-April 21.) 7000 w.

*12428. Concentric Wiring. Sam Mavor (El-April 21.) 1000 w.

*12441. Marine Electric Lighting. Ill. (E P-Jan. 1.) 63000 w.

12482. Henry Goebel. Ill. (E W-May 6.) 1350 w.

*12511. Municipal Ownership of Street Lighting Plants (P-May.) 1000 w.

12537. Electricity in the Naval Review. Ill. (E N Y-May 3.) 2500 w.

*12651. Notes on the Cost of Electric Lighting. F. B. Nicholson (E E L-April 28.) 2000 w.

12666. Sensational Charges Against the General Electric Company (E W-May 13.) 1500 w.

Serials.

6709. Electric Light and Power. Arthur F. Guy (E E L-Began Sept 9—19 parts to date—30 cts. each).

9906. Electric Light and Gas. Ed. C. De Segundo (E R L-Began Jan. 13—Ended March 31—4 parts—30 cts. each).

10844. The Design of a Central Station for Incandescent Electric Lights (E W-Began March 4—3 parts to date—15 cts. each).

11245. The Specification of Electric Plant and Mains for Open Competition. Thomas Tomlinson (E R L-Began March 3—Ended April 7—3 parts—30 cts. each).

11836. Can a Practical All Solid Incandescent Lamp without Vacuum Be Made? F. M. F. Cazin (E A-Began April 8—Ended April 22—2 parts—15 cts. each).

12230. The Story of the Evolution of the Edison Incandescent Lamp. Ill. (E W-Began April 22—2 parts to date—15 cts. each).

GAS ENGINEERING.

*11895. An Unconsidered Source of Error in Practical Photometry. H. Leicester Greville (J G L-March 28.) 1500 w.

*11995. The Comparative Cost of Gas and Electric Lighting. J. M. Turnbull (J G L-April 4.) 2800 w.

12030. Elevating a 24-inch Gas Main. Ill. J. B. Crockett (E N-April 13.) 2300 w.

12071. Governor Burners, with Discussion. Irwin Butterworth (P A-April 15.) 6000 w.

12072. Oils for Gas Enriching, with Discussion. Allen S. Miller (P A-April 15.) 3500 w.

*12102. Cyanogen in Gas Purification Oxide (G W-April 8.) 500 w.

*12258. Conveyors and Elevators for Gas-Works Purposes. Ill. (J G L-April 11.) 1500 w.

*12259. Experimenting with a View to the Development of Gasholder Construction. E. Lloyd Pease (J G L-April 11.) 850 w.

*12269. Gasworks' Plant for the Continent and the Colonies (G E M-April 10.) 4000 w.

*12270. Inaugural Address of E. C. Riley (G W-April 15.) 5000 w.

*12271. Notes on the Manufacture of Gas. W. Stagg (G W-April 15.) 2600 w.

*12469. The Hawkite Hydrogen Gas Process (G W-April 22.) 800 w.

*12565. F. T. C. Linton on Oil-Gas Processes (J G L-April 25.) 3500 w.

†12578. Test of a One Hundred Horse-Power Gas Engine Using Producer Gas. Ill. H. W. Spangler (J F I-May.) 4000 w.

12618. Advantages of Gas over Coal for Cooking and Heating Purposes. William Wallace Goodwin (A G L J-May 8.) 1700 w.

*12637. Gasfitting (G W-April 29.) 1300 w.

Serials.

11993. Oxid of Iron: A Monograph. John T. Sheard (J G L-Began April 4—4 parts to date—30 cts. each).

11994. Gas Works as Central Stations for the Supply of Light, Heat, and Power. W. von Oechelhaeuser (J G L-Began April 4—Ended April 11—2 parts—30 cts. each).

HYDRAULICS.

*11900. Iron and Steel Water Tanks. Abstract of paper by William C. Coffin, Jr. (I-March 31.) 1000 w.

†11955. Discussion on "The Use of Asphaltum for Reservoir Linings," by James D. Schuyler, R. C. Gemmell, C. B. Brush, S. Whinery, J. F. Flagg, W. B. Parsons, R. L. Harris, Foster Crowell, M. Fargusson, F. Collingwood, E. P. North, and J. F. O'Rourke (T C E-April.) 7000 w.

12029. The New Dam for the Water Works of Sante Fé, N. M. Ill. (E N-April 13.) 500 w.

12090. The Filtration of Water through Sand (E R-April 15.) 2000 w.

12217. The Long Island Water Supply Co. Case (E N-April 20.) 1000 w.

12218. Worthington High-Duty Pumping Engine at Philadelphia, Pa. Ill. (E N-April 20.) 2300 w.

12236. A Suburban Water Works System. Ill. (E R-April 22.) 900 w.

*12278. The Water Supply of Chicago. Editorial (E-April 14.) 1800 w.

†12307. The Use of Bone-Black in Domestic Filters, with Discussion. R. N. Clark (E S W P-Feb.) 5900 w.

†12330. Australian Irrigation. E. D. Millan (A P R-March 15.) 2500 w.

*12349. The Duty of Pumping Engines. John H. Barr (S J E-April.) 2000 w.

12354. Operating the San Antonio, Tex., Water Works by Electric Motor. Ill. (E E N Y-April 26.) 500 w.

12381. Diagrams for Hydraulic Formulas. Ill. A. L. Adams and R. G. Gemmell (E N-April 27.) 1300 w.

12486. Some Large Water Power Stations. Ill. (E W-May 6.) 800 w.

12593. Areas and Capacities of Dams. Ill. (P S-May.) 700 w.

12619 Eight Feet of Mud in a Cincinnati Reservoir (F W-May 6.) 1600 w.

INDUSTRIAL CHEMISTRY.

*12098. Estimation of Arsenic and Phosphorus in Iron Ores, etc. John Pattinson and H. S. Pattinson (I-April 7.) 2400 w.

*12153. Calorimetric Determination of Coal. Ill. (Eng L-April 7.) 2500 w.

Serials.

11049. The Applications of Ozone. Ill. (E R L-Began Feb. 24—Ended March 31—5 parts—30 cts. each).

11891. Water Analysis. H. Van F. Furman and Prof. Tilden (Sc Q-Began March—1 part to date—45 cts).

12475. Applications of Ozone. Appendix (E R L–Began April 21—Ended April 28—2 parts—30 cts. each).

12603. Facts and Figures on Electrolytic Chlorine and Soda. Emile Andreoli (E R L–Began April 28—1 part to date—30 cts).

INDUSTRIAL SOCIOLOGY.

*11852. What Will the Democrats Do? A forecast of tariff legislation. John DeWitt Warner (E Mag–June.) 3000 w.

12041. The Coming Scale Discussion. Editorial (A M & I W–April 14.) 800 w.

12043. Labor in Europe. Participation in Profits and Pensions (B J C–April 15.) 1200 w.

12059. The Law of Strikes.—Decision of Judge Emery Speer (A & B–April 15.) 700 w.

*12085. The Eight Hour Day.—What Does Experience Teach? "Yorkshireman in London" (R R L–April 7.) 1850 w.

*12166. Signalmen and Their Hours. Editorial (A J R A–April.) 900 w.

*12182. Organized Labor and the Law. Edward Arden (Ch–May.) 3200 w.

†12190. The Social Remedies of the Labor Party. W. H. Mallock (F R–April.) 9300 w.

*12255. Strikes and Lock-outs, Old and New (J G L–April 11.) 1900 w.

*12306. The Labor Troubles at Hull (I L–April 14.) 400 w.

12308. Another Railway Employés' Union. Editorial (R A–April 21.) 1000 w.

*12319. The Hull Dock Strike. Editorial (Eng L–April 14.) 1600 w.

12320. The Interstate Law vs. the Walking Delegate. Thomas Coram (B C–April 22.) 800 w.

12336. A Campaign of Education. Editorial (R R–April 22.) 700 w.

12339. How Monopolies End (A S–April 22.) 600 w.

12340. Revival of Arbitration. Editorial (A S–April 22.) 600 w.

12341. Some Stoppages of Labor and Their Causes (A S–April 22.) 700 w.

†12369. Recent Labor Rulings by Federal Courts. Aldace F. Walker (F–May.) 4800 w.

†12370. Compulsory Arbitration an Impossible Remedy. Carroll D. Wright (F–May.) 4000 w.

†12371. Menacing Socialism in the Western States. Frank B. Tracy (F–May.) 5200 w.

†12373. How to Introduce the Initiative and Referendum. W. D. McCrackan (A–May.) 2200 w.

12385. Profit Sharing and the Labor Problem. A Workman (A M–April 27.) 700 w.

12392. Demands of Labor Unions (M S P–April 22.) 2000 w.

12411. Federal Intervention in Strikes. Editorial (I T R–April 27.) 600 w.

12416. The Supervision and Regulation of Corporations.—The Way Not to Do It. Allen R. Foote (S R N–April 29.) 2500 w.

*12429. The Threatened Dock and Shipping Strike.—A Review of the Situation (Tr–April 21.) 4400 w.

12434. The Nationalization of a Trade Union. Thomas Coram (B C–April 29.) 700 w.

*12437. The Strike at Hull. Editorial (I L–April 21.) 1200 w.

*12470. An Act of Trade Unionism (B A–April 21.) 1300 w.

†12502. The Ann Arbor Strike. Frank P. Sargent (N A R–May.) 2000 w.

†12505. Is Land Held Out of Use? William B. Cooper (N A R–May.) 850 w.

*12507. How a Socialist Millennium Would Work.—Eugene Richter's Pictures of the Future (R of R–May.) 14000 w.

12523. Convicts and Highways. Editorial (A S–April 29.) 600 w.

12539. Trusts. Philosoph (E N Y–May 3.) 1800 w.

*12634. The Regulation of Ironworkers' Wages in Staffordshire and the North of England (C G–April 28.) 1500 w.

*12639. The American View of Sympathetic Strikes. Editorial (Tr–April 28.) 1700 w.

12642. A Just Distribution of Earnings. Editorial (A M & I W–May 5.) 1000 w.

*12647. The Practicability of the Legal Eight Hour Day. "Yorkshireman in London." (R R L–April 28.) 1400 w.

12657. Fictitious Corporate Capitalization. James A. Logan (R R–May 6.) 3000 w.

12658. The Problem of the Unemployed. Editorial (A S–May 6.) 800 w.

12677. Labor and Law. A. B. Salom (I I G–March.) 1500 w.

Serials.

12282. Labor in Germany (E–Began April 14—2 parts to date—30 cts. each).

LANDSCAPE ENGINEERING.

11958. Some Uses of Formal Gardening (G & F–April 12.) 1000 w.

12506. Landscape Art in Public Parks (G & F–May 3.) 1500 w.

MARINE ENGINEERING.

*11854. The Latest and Greatest Cunarder. Ill. A Clydesider (E Mag–June.) 3000 w.

*11871. The Flensburg Off-Shore Floating Dock. Ill. (Eng L–March 31.) 1400 w.

*11922. Discussion of F. Elgar's paper, "The Strength of Bulkheads" (E–March 31.) 2500 w.

*11923. Discussion of paper by George A. Calvert, "The Measurement of Wake Currents" (E–March 31.) 900 w.

*11926. The Atlantic Passenger and Emigrant Trade. Editorial (E–March 31.) 850 w.

*11928. Historic Figure-Heads. Ill. Robert G. Denig (Cos–April.) 3000 w.

*11946. Chapman's Mathematical Propeller. Ill. Gavin Chapman (S L–April.) 1500 w.

*11948. English vs. American Ship Paints (S L–April.) 700 w.

*11949. Types of Mercantile Steamers (S L–April.) 900 w.

12020. The Famous Old Collins Line. Ill. (Sea–April 13) 900 w.

12021. Why Our Boys Don't Go to Sea. Editorial (Sea–April 13.) 1000 w.

12022. "The American Merchant Service," Its Needs and Abuses. Richard P. Joy (Sea–April 13.) 1500 w.

12057. An Interesting Letter About Foreign Engineers, with Editorial (Eng–April 15.) 1500 w.

12078. Hollow Shafting in Modern Steamships (S V–April 15.) 800 w.

12080. The Ward Boilers Fail on the New Coast-Defense Battle-Ship "Monterey" (S V–April 15.) 900 w.

12081. Will It Beat the Steam Engine? G. Sheffield's Rapid Motor (S V–April 15.) 700 w.

*12115. Shipping Charges and British Industry. Editorial (E–April 7.) 1500 w.

*12116. European Canals. Editorial (E–April 7.) 2000 w.

*12119. On the Measurement of Wake Currents. Ill. G. A. Calvert (E–April 7) 4000 w.

*12120. The Strength of Bulkheads. F. Elgar (E–April 7.) 3300 w.

*12127. Progress of Shipbuilding in America. Editorial (I L–April 7.) 1000 w.

*12157. The New Harbor of Venice. Editorial (I C T–April 7.) 600 w.

†12178. Growth of Our Knowledge of the Deep Sea. G. W. Littlehales (P S M–May.) 2800 w.

12223. The Harbor of Charleston, S. C. I. W. Avery (M R–April 21.) 800 w.

12226. The Steamboat Inspection Service Considered as It Is by an Expert, Who Says What It Should Be. Howard Patterson (Sea–April 20.) 1200 w.

12227. Conditions and Needs of American Shipping. Thomas W. Hyde and Philip N. Hichborn (Sea–April 20.) 2500 w.

*12276. Boat Railway at Meaux, France. Ill. (E–April 14.) 1100 w.

*12277. The Clyde Passenger Steamer "Isle of Arran." Ill. (E–April 14.) 1600 w.

*12280. Merchant Cruisers. Editorial (E–April 14.) 1000 w.

*12283. The Vibrations of Steamers. Ill. Otto Schlick (E–April 14.) 6000 w.

*12314. The Fastest Paddle Steamer in the World.—Belgian Mail Steamship Leopold II. Ill. (Eng L–April 14.) 2000 w.

*12316. The Draughtometer. Ill. (Eng L–April 14.) 1700 w.

12393. Brief Description of the Ships in the Columbian Naval Celebration. Ill. (Sea–April 27.) 3500 w.

12403. Salvage Services. Editorial (M Rec–April 27.) 1000 w.

*12430. Production, Prices, and Wages in Ship building (Tr–April 21.) 1500 w.

*12439. The Cunard Royal Mail Twin-Screw Steamers "Campania" and "Lucania." Ill. (E–April 21.) 33000 w

*12478. The Propulsion of Ships. Editorial (Eng L–April 21.) 1350 w.

12488. Electric Launches at the World's Columbian Exposition (E R N Y–May 6.) 700 w.

*12526. Boiler Tubes. Ill. (A E R J–May.) 4000 w.

12552. Ice-Harbors in the Delaware River and Bay. Ill. A. Stierle (E N–May 4.) 5300 w.

*12597. United States Atlantic Liners. Editorial (Eng L–April 28.) 1150 w.

*12599. Compound Marine Engines. Editorial (Eng L–April 28.) 1500 w.

Serials.

11127. Resistance to Ship's Motion. A Natural Law Newly Discovered. F. M. F. Cazin (J F I–Began March—Ended May—3 parts—45 cts. each).

11978. Some of My Experiences as an Engineer on the Niger. John Parkin (E G–Began April—1 part to date—30 cts).

12250. Capt. Alexander McDougall's Patents. Since Application for a Patent on the Whaleback Type of Vessel (M R C–Began April 20—2 parts to date—15 cts. each).

MECHANICAL ENGINEERING.

11859. The American Passenger Elevator. Thomas E. Browne, Jr. (E Mag–June.) 3000 w.

*11868. Great Western Manufacturing Company. Ill. (E I–April.) 1200 w.

12008. The Cost and the Value of Compressed Air (A M–April 13.) 600 w.

12009. Foundry Talk. Charles Smith (A M–April 13.) 1300 w.

12084. Practical View of the Case. Over-Production of Machines. C. R. Tompkins (A S–April 15.) 900 w.

*12140. Some Valuable Hints to Inventors. Review of R. Grimshaw's "Tips to Inventors" (Inv–April 8.) 2800 w.

*12313. Roller and Ball Bearings. Ill. (Eng L–April 14.) 3000 w.

12335. Unloading the Large Krupp Gun. Ill. (R R–April 22.) 700 w.

12387. Coe Brass Manufacturing Company. F. J. M. (A M–April 27.) 3000 w.

12394. Charging Machine for Blooming Mills. Ill. (Ir Age–April 27.) 1000 w.

*12559. A Weldless Chain, with Discussion. Ill. Ludwig Herman (J A E S–March.) 4500 w.

12613. Concerning Lubricators. W. H. Wakeman (M G–May 6.) 950 w.

12655. A Powerful Excavator. Ill. (R R–May 6.) 600 w.

12659. Special Machines and Improvements. C. R. Tompkins (A S–May 6.) 1200 w.

Serials.

11569. The Mannesmann Process of Seamless Tube Rolling (M W-Began March 17—4 parts to date—30 cts. each).

11904. Engineer's Cutting Tools. Ill. Thomas Foster (P Eng-Began March 31—Ended April 7—2 parts—30 cts. each).

12142. On Machine Designing (M W-Began April 7—2 parts to date—30 cts. each).

METALLURGY.

*11855. Evolutions of the Iron-Founder's Art. Stephen Bolland (E Mag-June.) 3000 w.

11865. A New Grouping for Pig Iron and Other Substances (E M J-April 8.) 900 w.

11866. The Russell Process at Sombrerete, Mexico. Fred M. Watson (E M J-April 8.) 1400 w.

11867. The Development of Some Ontario Ores. T. D. Ledyard (E M J-April 8.) 700 w.

†11888. The Assay of Gold and Silver Ores. H. Van F. Furman (Sc Q-March.) 3700 w.

†11889. Design for Assay Furnace. Ill. James L. Wells (Sc Q-March.) 1000 w.

†11890. The Determinating of Copper by the Iodide Method. G. E. Jewell (Sc Q-March.) 1000 w.

*11927. Alloys: Abstract of 4th Lecture by W. C. Roberts-Austen (E-March 31.) 2300 w.

*11936. Determination of Phosphorus in Iron and Steel. Adolphe Carnot (C G-March 30.) 1300 w.

11982. Home Steel for the South. Editorial (A S-April 8.) 750 w.

11983. The Waste Heat of Coke Ovens (A S-April 8.) 600 w.

*11997. Gold Amalgamation. The Ideal Amalgamator. C. G. Wamford Lock (A M S-Feb. 25.) 1400 w.

12018. The Buffalo Furnace. Ill. (Ir Age-April 13.) 2100 w.

12019. The First Blast Furnace in America. Ill. W. N. Adams (Ir Age-April 13.) 5800 w.

12032. What Shall We Do with Our Rail Mills? (E N-April 13.) 2000 w.

12063. The Construction of Lead Blast Furnaces. Ill. H. O. Hoffman (E M J-April 15.) 2200 w.

*12099. Magnetite in Minerals and Rocks. A. Liversidge (I-April 7.) 1350 w.

*12128. The Tin-Plate Industry of the United States (I L-April 7.) 1000 w.

*12129. The Manufacture of Alumina (I L-April 7.) 1500 w.

*12131. The Limits of Accuracy in Gold Assay (I L-April 7.) 800 w.

*12141. Some Remarks on Steel. Walter J. May (Inv-April 8.) 1100 w.

*12149. Notes on Emmerton's Method for the Determination of Phosphorus. H. C. Babbitt (C G-April 7.) 900 w.

12213. Wainwright's Process for Reducing Low Grade Ores. Ill. (I T R-April 20.) 1100 w.

12220. The Nan Method of Casting Sound Ingots. Ill. ¶Ir Age-April 20.) 1000 w.

12221. Can Tin Plate Be Too Good? Editorial (Ir Age-April 20.) 700 w.

12265. Standard Methods for Metallurgical Chemists. Editorial (E M J-April 22.) 1500 w.

*12286. Compounding Blowing-Engines. T. Westgarth (I-April 14.) 1700 w.

12405. Segregation in Metals (E M J-April 29.) 1500 w.

*12455. Mild Open-Hearth Steel for Castings, with Discussion. A. B. Winder and J. Dixon Brunton (I-April 21.) 6000 w.

*12456. Hammering vs. Cogging (I-April 21.) 900 w.

*12457. The Utilization of Blast Furnace Slag. R. Zsigmoudy (I-April 21.) 1100 w.

*12464. The Recent Growth of Foreign Mineral Industries (C G-April 21.) 1500 w.

*12465. Sulphur and Phosphorus in Iron (C G-April 21.) 1500 w.

*12476. The Ludhoe Iron and Steel Works, Spennymoor. Ill. (Eng L-April 21.) 5500 w.

12521. Iron and Steel. B. F. Spalding (A S-April 29.) 2500 w.

*12530. A New Method of Smelting and Casting Metals. Ill. (A E R J-May.) 800 w.

*12601. Tensile Tests and Chemical Analyses of Copper Plates from Fire-Boxes of Locomotives on the Great Western Railway. Abstract of Paper by William Dean (I L-April 28.) 1800 w.

*12621. Technical Importance of Aluminum and Its Future Applications. J. Klaudy (I-April 28.) 1900 w.

*12633. Manganesiferous Iron (C G-April 28.) 1300 w.

12641. Objections to By-Product Coke Ovens (A M & I W-May 5.) 1200 w.

*12673. On Copper Smelting in Russia (I & S-April 29.) 2800 w.

Serials.

9459. The Manufacture of Coke. Ill. John Fulton (C E-Began Jan.—5 parts to date—30 cts. each).

10275. The Analysis of Iron and Steel. J. Parry and J. J. Morgan (I L-Began Jan. 27—4 parts to date—30 cts. each).

10971. Resistance of Metals to Shear. H. V. Loss (A E R J-Began March—3 parts to date—30 cts. each).

11736. The American Tin-Plate Industry (I-Began March 24—2 parts to date—30 cts. each).

11901. Paints for Metallic Structures. John Newman (I-Began March 31—Ended April 7—2 parts—30 cts. each).

11998. Crushing Rolls. F. Danvers Power (A M S-Began Feb. 25—2 parts to date—30 cts. each).

12159. Technical Education for the Molder. S. Bolland (F D-Began April 10—1 part to date—15 cts).

12195. Molding by Machinery — Foundry

Appliances, etc. Ill. S. Bolland (A M-Began April 20—1 part to date—15 cts).

12206. The Sulphid Question—A Proposed System of Treatment (A M S-Began March 18—1 part to date—30 cts).

12267. The Bessemerizing of Copper Matte, and Production of Pig Copper. Ill. Charles Wade Stickney (E M J-Began April 22—Ended May 6—3 parts—15 cts. each).

12406. Variations in the Milling of Gold Ores—Ballarat, Victoria. Ill. T. A. Rickard (E M J-Began April 29—Ended May 6—2 parts—15 cts. each).

12458. The Effects of Alloys on the Mechanical and Physical Properties of Metals. W. C. Roberts-Austen (I-Began April 21—2 parts to date—30 cts. each).

MILITARY ENGINEERING.

*11925. Quick-Firing Guns in the Field. Editorial (E-March 31.) 2300 w.

12005. The First War Steamer of the World. Ill. (Sc A-April 15.) 1200 w.

*12184. The Standing Army of the United States. Guy Howard (Ch-May.) 4400 w.

*12252. The Society of the Cincinnati. Ill. John Bunting (L Mag-May.) 3200 w.

12264. The Wire-Wound Gun.—It Withstands a Pressure That Would Blow Any Other Gun to Atoms (B J C-April 22.) 500 w.

*12318. Umpire's Report on the Naval Manœuvres, 1892. Editorial (Eng L-April 19.) 2200 w.

*12347. The Construction of Guns at the Washington Navy Yard. E. B. Clark (S J E-April.) 2500 w.

*12350. Prison Life at Belle Isle. Ill. Joseph C. Helm (Cos-May.) 5200 w.

†12372. Anomalies of Our Private Pension System. Thomas F. Dennis (F-May.) 4200 w.

12383. The White Magazine Rifle. Ill. (E N-April 27.) 700 w.

12420. Statue of John Ericsson (A & N J-April 29.) 3500 w.

12421. The International Naval Review (A & N J-April 29.) 3800 w.

12435. Smokeless Powder. Editorial (A & N R-April 29.) 650 w.

*12443. Invisible Torpedo Boats (M W-April 21.) 650 w.

*12480. Improvements in Naval Armor. Editorial (Inv-April 22.) 1900 w.

†12495. Military Misconceptions and Absurdities. James Chester (J M S I-May.) 6500 w.

†12496. Some Remarks on Our New Cavalry Drill Regulations. W. H. Smith (J M S I-May.) 6600 w.

†12497. The Military Uses of Photography. A. Williams (J M S I-May.) 6500 w.

†12499. An Historical Sketch of the Evolution of Tactics. Translated from the German by William C. Rawolle (J M S I-May.) 7500 w.

†12504. Further Views of Pension List Revision. Wheelock C. Veazey, Joseph H. O'Neil, and B. A. Enloe (N A R-May.) 5000 w.

*12528. The Ericsson Submarine Gun. Ill. (A E R J-May.) 500 w.

12534. The Naval Parade and Review. Ill. (Sc A-May 6.) 2000 w.

12544. The British Admiralty List of Reserved Merchant Cruisers (Ir Age-May 4.) 1000 w.

12549. The Katahdin.—American Coast Defense Ram. Ill. (Sea-May 4.) 3000 w.

12590. Naval Land Parade—April 28 (A & N J-May 6.) 3500 w.

12591. Report on Trials of the Wire-Gun (A & N J-May 6.) 1200 w.

12678. Wonderful Armor Plate (I I G-March.) 1200 w.

Serials.

9347. Notes of Lectures on Artillery in Coast Defense. A. C. Hansard (J M S I-Began Jan.—3 parts to date—45 cts. each).

10738. The Development of American Armor Plate. Ill. F. Lynwood Garrison (M-Began Feb. 15—3 parts to date—30 cts. each).

12427. The Construction and Uses of Projectors. F. Nerz (El-Began April 21—Ended April 28—2 parts—30 cts. each).

MINING.

†11892. The Geological Training of a Prospector. Ill. A. Lakes (Sc Q-March.) 3300 w.

†11893. Notes on Mine Surveying. C. M. Eye (Sc Q-March.) 3000 w.

†11894. A New Era in Mining Machinery. Ill. M. C. Ihlseng (Sc Q-March.) 2000 w.

*11914. The Estimation of the Actual Effective Pressure or Water Gauge in the Ventilation of Mines. T. A. Southern (I C T-March 31.) 3000 w.

*11929. The Great Florida Phosphate Boom. Ill. A. Allen (Cos-April.) 4000 w.

*11930. Some Biographical Sketches of Miners, Metallurgists, and Allied Workers. Ill. (Inv-March 25.) 11500 w.

*11931. Electrical Shot Firing. Ill. (Inv-March 25.) 1800 w.

*11932. Roburite and High Explosives. Editorial (Inv-March 25.) 800 w.

*11935. Working Electric Signals from the Electric Light Service in Mines. Sydney F. Walker (C G-March 30.) 1700 w.

*11937. The Determination of Firedamp by the Limits of Inflammability. M. H. Le Chatelier (C G-March 30.) 1800 w.

11979. Present Condition and Future of Mining. Editorial (M I T-April 6.) 1500 w.

12037. The Gold Field of Virginia (M R-April 14.) 600 w.

12062. The Monte Cristo Mining District, Washington. Ill. R. H. Stretch (E M J-April 15.) 900 w.

12083. Electricity in Mining Industries. Editorial (A S-April 15.) 600 w.

*12168. Coal (A J R A-April.) 850 w.

12173. The Coals of Colorado (M I T-April 13.) 2500 w.

12193. The Yukon River Region (M S P-April 15.) 1800 w.

12194. The Kootenai Country (M S P-April 15.) 1350 w.

*12201. The Mount Lyell Copper Mine—An Extraordinary Deposit. Dr. Peters (A M S-March 4.) 1500 w.

*12203. Tin Saving. Phœnix (A M S-March 11.) 1600 w.

*12204. Mining near Yea (Vic.) (A M S-March 11.) 1000 w.

12251. Coal of the World (M G-April 22.) 2200 w.

12263. Chalk Beds of Texas—The Greatest Chalk Region in the World (B J C-April 22.) 1500 w.

12266. The Reynoldsville, Pa., Coal Field and a Novel Drainage System. Ill. Frank M. Brown (E M J-April 22.) 1700 w.

*12279. The Mining Royalties Commission. Editorial (E-April 14.) 3200 w.

*12281. The Production of Minerals in the United Kingdom in 1892 (E-April 14.) 1200 w.

*12305. Mineral Royalties and Manufacturing Industry. Editorial (I L-April 14) 1250 w.

*12327. Bas-Boulonnais Coal Measures. Ill. Ludovic Breton (C G-April 14.) 3000 w.

*12328. The Useful Effect of a Rateau Fan. A. Macquet (C G-April 14.) 4800 w.

*12329. Extraordinary Outbursts of Soft Coal and Gas. Joseph Dickinson (C G-April 14.) 3300 w.

12334. Machinery and Mining. Editorial (M S R-April 20.) 900 w.

12343. Loss of Life in Mine Explosions. Editorial (M I T-April 20.) 550 w.

12344. The Gold Mines of India (M I T-April 20.) 800 w.

12391. Progress of Mining in New Zealand (M S P-April 22.) 2500 w.

12408. Waste in Mining and Preparing Anthracite Coal (E M J-April 29.) 800 w.

12436. The First Petroleum Company (O P D R-May 1.) 1300 w.

*12444. The Economic Geology of Mercury. Ill. H. A. Wheeler (C E-May.) 1800 w.

*12447. Pump Valves.—The Various Types in Common Use. Ill. Dugald Baird (C E-May.) 3500 w.

*12448. A History of Coal Mining. Fred. C. Keighley (C E-May.) 4000 w.

*12451. Conditions to Be Taken into Consideration in Opening Up a Mine. M. C. Ihlseng (C E-May.) 1200 w.

*12466. A New Process of Blasting by Explosives : A Contribution to the Solution of the Fire-Damp and Coal Dust Problems. F. Pfieffer (C G-April 21.) 2000 w.

*12467. Prevention of Overwinding. M. V. Triprier (C G-April 21.) 2000 w.

*12468. Communication between Cage and Bank. M. Janet (C G-April 21.) 1600 w.

*12479. Gold Mining in India. Editorial (Eng L-April 21.) 1100 w.

12515. Electric Haulage in the Rock Springs Coal Mines, Wyoming. Ill. (E E N Y-May 3.) 500 w.

12524. Science in Mining. Editorial (M I T-April 27.) 1000 w.

12525. Two Mining Accidents (M S R-April 27.) 1600 w.

*12606 Depression in the Mining and Metallurgical Industries (E-April 28.) 800 w.

*12629. Mine Blasting with Maximum Effect and Minimum Danger. J. W. P. (C G-April 28.) 2500 w.

*12631. Non-Inflammability of Firedamp through the Miner's Pick (C G-April 28.) 1200 w.

*12632. Lateral Influence of Subsidence in Mines. M. H. Villot (C G-April 28.) 1400 w.

*12638. The Park Slip Colliery Explosion (I C T-April 28.) 650 w.

12679. The Cause of Ore Chutes. A. F Wuensch (M I T-May 4.) 1000 w.

12681. Economic Geology of North Carolina. Ill. J. A. Holmes (S S-May.) 4500 w.

Serials.

9003. Diamonds in India : A Rechauffée. W. King (I E-Began Nov. 19—5 parts to date—45 cts. each).

10645. Croydon. (N. Q.) Jno. Harvey (A M S-Began Jan. 14—4 parts to date—30 cts. each).

11282. Mine Ventilation Made Easy. W. Fairley (C E-Began March—3 parts to date—30 cts. each).

11385. Selecting and Calculating a Fan, with Tests of Rateau Fans (C G-Began March 10—3 parts to date—30 cts. each).

11574. The Mineral Resources of the Southern States (I L-Began March 17—2 parts to date—30 cts. each).

11801. Information to Aid in the Search for Gold and Silver. Ill. Arthur C. Lakes (C E-Began April—2 parts to date—30 cts. each).

11804. Fire-Damp. H. LeChatelier. Translated by H. H. Stock (C E-Began April—2 parts to date—30 cts. each).

11820. From Mine to Furnace. John Birkinbine (J F I-Began April—Ended May—2 parts—45 cts. each).

11945. Three River Bog Iron Ores. A. P. Lowe (I & S-Began April 1—Ended April 8—2 parts—30 cts each).

12205. Tin Deposits, Brookstead Estate, Tasmania (A M S-Began March 18—1 part to date—30 cts).

12222. The Iron Ores of North Carolina (M R-Began April 21—2 parts to date—15 cts. each).

12402. The State Chemist's Report on Florida Phosphates (M R-Began April 28—2 parts to date—15 cts. each).

12450. The Coal Fields of Canada. William Hamilton Merritt (C E-Began May—1 part to date—30 cts).

RAILROADING.

*11856. The Trans-Siberian Railway. Frederick Hobart (E Mag–June.) 3000.

11862. The Development of Fixed Signals on Railroads. Ill. Arthur H. Johnson (R G–April 7.) 3800 w.

11902. Railway Progress and Railway Poverty. Ossian D. Ashley (R A–April 7.) 2200 w.

11903. "Pennsylvania Tours to the Golden Gate." Ill. (R A–April 7.) 1400 w.

11905. The Advantage of Smaller Engines for Fast Passenger Service. Editorial (R M M–April.) 1400 w.

11906. The Care of Foundation Brakes. Ill. E. J. with Editorial (R M M–April.) 2200 w.

11907. Reinforcing Brake Apparatus. Ill. (R M M–April.) 1500 w.

11917. Railroads, Men and Laws. Frederick E. Goodrich (B C–April 8.) 1000 w.

11950. Painting of Passenger Cars. Ill. Duane Doty (R C J–April.) 1500 w.

11951. Contagion in Passenger Cars (R C J–April.) 500 w.

†11957. Street Motors on the Government Tramways at Sydney, New South Wales. George Downe (T C E–Feb.) 1000 w.

*11963. Curve Resistances (R P L–April 1.) 1900 w.

*11964. Sunday Work on German Railways (R P L–April 1.) 700 w.

*11965. The South African "Pullman Car." Ernest J. Price (R P L–April 1.) 1800 w.

11974. Railroad Management, Past, Present, and Prospective. Quintin McNab (R R–April 8.) 2000 w.

11975. The Auditing of Express Accounts. Editorial (R R–April 8.) 1150 w.

11976. The Ann Arbor Cases.—Judge Rick's Decision (R R–April 8.) 4000 w.

11991. Electric Railroads and Electrolysis. Editorial (E E N Y–April 12.) 1000 w.

12013. The Boynton Electrical Bicycle Road. Ill. (E W–April 15.) 1600 w.

12028. Four-Track Steel Viaduct; New York Central and Hudson River R. R. (E N–April 13.) 1900 w.

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12047. The Block Signals in the Fourth Avenue Tunnel (R G–April 14.) 2000 w.

12048. Some of the Questions before Railroad Managers. H. S. Haines (R G–April 14.) 1900 w.

12049. Railroad Matters in Colombia. S. B. M'Connico (R G–April 14.) 1500 w.

12050. The Recent Injunction Cases. Editorial (R G–April 14.) 1250 w.

12051. Railroad Mortgages and Earnings. Editorial (R G–April 14.) 900 w.

12052. An Episode in New York Rapid Transit (R G–April 14.) 700 w.

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12073. The Commercial and Political Considerations Involved in Sympathetic Railroad Strikes. Joseph Nimmo, Jr. (R R–April 15.) 2500 w.

12074. The Automatic Vacuum Brake as Used in England. Ill. (R R–April 15.) 1000 w.

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12076. Judge Taft's Decision (R R–April 15.) 4500 w.

12077. A Terrible Locomotive Boiler Explosion.—Near Butte, Montana. Ill. (S V–April 15.) 1600 w.

12111. The Federal Control of Railways. S. M. Cullom (R A–April 14.) 2800 w.

12112. Amendment of Line on Northern Pacific Railroad.—The Granite Viaduct, with Editorial. Ill. J. W. Kendrick (R A–April 14.) 4200 w.

*12133. Speed Registering Attachment for Locomotives (P Eng–April 7.) 700 w.

*12165. The Lake Shore and Michigan Southern Railway. Ill. C. P. Leland (A J R A–April.) 3800 w.

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12219. A Plan Adopted for Rapid Transit in New York City (S R N–April 22.) 1200 w.

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12238. Letter from A. M. Waitt in reply to criticism of his paper, "The M. C. B. Type of Coupler" (R G–April 21.) 2000 w.

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12244. An Official Utterance on Signalling (R G–April 21.) 2500 w.

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*12300. A Railroad Advertising Bureau.—Something About Time-Tables. George C. Johnson (R'y N–March.) 1100 w.

*12301. Central Buys the Northern.—Vanderbilts Have a Monopoly of All Railroads Entering New York from the North (R'y N–March.) 600 w.

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12310. The Staying of Crown Sheets. W. F. Dixon (R A–April 21.) 1000 w.

*12317. Railways in European Turkey. Map (Eng L–April 14.) 1000 w.

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12331. Street Railway Law in Connecticut S R G–April 22.) 350 w.

12332. Signal Tower of the Chicago City Railway. Ill. (S R G–April 22.) 900 w.

12333. The Electric Railway in Bangkok (S R G–April 22.) 1000 w.

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12338. Reasonable Rates.—Report of Committee of the Railroad Commissioners of the United States (R R–April 22.) 3800 w.

12360. Storage Battery Cars on Second Avenue (E R N Y–April 29) 500 w.

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†12374. Railway Tariffs. James L. Cowles (A–May.) 2700 w.

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*12474. Tramways vs. Telephones. S. Sellon (E E L–April 21.) 2600 w.

12483. The Intra-Mural Railway at the World's Fair. Ill. (E W–May 6.) 5000 w.

*12490. Laying Out Shoes and Wedges. G. K. W. (L E–May.) 1000 w.

†12491. Studies in Track and Roadway Construction. Ill. (S R J–May) 1600 w.

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†12493. Tacoma, Wash. Ill. (S R J–May.) 3500 w.

†12494. Seattle, Wash. Ill. (S R J–May.) 7800 w.

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12516. Early Locomotives on the London and Northwestern Railway. Ill. (R R–April 29.) 300 w.

12517. M. C. B. Coupler Tests. Editorial (R R–April 29.) 1800 w.

12518. Thirty-ninth Annual Report of the Chicago, Burlington and Quincy R. R. (R R–April 29.) 1500 w.

12520. How Grade Crossings May Be Abolished in Chicago. Harvey E. Park (R R–April 29) 1400 w.

12522. Regulation of Electric Railroads. Editorial (A S–April 29) 700 w.

*12529. Crossings of Great Rivers.—A Contribution to Railroad Location. Appendix. Ill. A. Zdziarski (A E R J–May.) 1800 w.

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12553. A Natural Railway Tunnel. Ill. Emile Low (E N–May 4.) 1500 w.

12556. American, English, and Indian Railways.—Railways (E N–May 4.) 4000 w.

*12557. Notes on English Railways. E. R. Turner (J A E S–March.) 7500 w.

12566. Equipment of Electric Cars. E. C. Westcott and E. Craig (C E N–May.) 2000 w.

12570. A Chapter of Recent English Railroad History. W. M. Acworth (R G–May 5.) 2000 w.

12571. The New York and Chicago 20-Hour Train. Editorial (R G–May 5.) 900 w.

12572. Russian Railroads (R G–May 5.) 900 w.

12587. Standard Suburban Coach—Illinois Central Railroad. Ill. (R C J–May.) 1000 w.

12588. The Importance of Varnish in the Maintenance of Passenger Equipment. Charles E. Copp (R C J–May.) 800 w.

12589. The Varieties of Woods Used in the Construction of Freight and Passenger Cars, at Pullman, Ill. D. Doty (R C J–May.) 1800 w.

*12596. Winby's Express Locomotive. Ill. (Eng L–April 28.) 1100 w.

*12598. Railway Accidents. Editorial (Eng L–April 28.) 1500 w.

*12600. The Pool and Hamworthy Junction Railway. Ill. (I L–April 28.) 1600 w.

†12624. Madras Railway Company (I E–April 1.) 1200 w.

*12635. Coal Production and Railway Demands in India (C G–April 28.) 1600 w.

*12643. The Great Eastern Railway and the Stratford Works. Ill. (R W–April.) 8500 w.

*12644. The Railway Commissioners of New South Wales on English Locomotives. Ill. (R W–April.) 1300 w.

*12645. The Cleaning of Tramway and Other Rails. H. Couradi (R W–April.) 3600 w.

*12646. Fines on Railways. Editorial (R R L–April 28.) 1000 w.

12648. An Old Fashioned Rate War. Editorial (R A–May 5.) 600 w.

12649. Some Practical Talk to Track Men. E. P. Hawkins (R A–May 5.) 1200 w.

12652. Why Railway Rates Are Based on Distance in Local Traffic. Jas. L. Cowles (R R–May 6.) 1800 w.

12653. Signals and How They Should Be Handled. Signal (R R–May 6.) 900 w.

12656. A Question of Classification. Editorial (R R–May 6.) 1000 w.

12661. Rapid Transit in Boston. Editorial (E R-May 6.) 1550 w.

12672. The Electrical Illumination of Steam Railroad Cars (E W-May 13) 700 w.

Serials.

7456. The Locomotive Boiler, Ill. Gustav Richard (A J R A-Began Oct.—Ended April—6 parts—30 cts. each).

9254. Railway Management. Horace Cope (R R-Began Dec. 31—5 parts to date—15 cts. each).

9689. Railroad Car Design. Ill. Archer Richards (R C J-Began Jan.—5 parts to date—15 cts. each).

10502. English and American Railways. Ill. William M. Acworth (E Mag-Began April—3 parts to date—30 cts. each).

11896. The Madras Electric Tramway Company (I E-Began March 4—2 parts to date—45 cts. each).

11897. Proposed Calcutta Tunnel. Ill. William Duff Bruce and J. H. Greathead (I E-Began March 4—2 parts to date—45 cts. each).

11921. Earth Slips and Subsidences. Ill. Henry E. P. Cottrell (E-Began March 31—Ended April 7—2 parts—30 cts. each).

11962. The History of the South-eastern Railway. G. A. Sekon (R P L-Began April 1—1 part to date—30 cts).

12001. Rails on the Creep. A. Ewbank (I E-Began March 11—3 parts to date—45 cts. each).

12177. The First Electric Railway in New Orleans. Ill. A. Langstaff Johnston (E E N Y-Began April 19—2 parts to date—15 cts. each).

12527. Patenall's Improved Sykes' System of Block Signals (A E R J-Began May—1 part to date—30 cts).

12614. Railway-Stations. Ill. Léon Benouville (A A-Began May 6—1 part to date—15 cts).

SANITARY ENGINEERING.

11941. Dry Closets at the Pencoyd Iron Works. Ill. (E R-April 8.) 500 w.

†11953. Discussion on "The Storm Hydro-Pneumatic System of Sewerage." F. P. Stearns, J. J. R. Croes, J. Foster Flagg, William L. Saunders, William Barclay Parsons, A. Fteley, F. W. Skinner, Rudolph Hering, and U. H. Broughton (T C E-Feb.) 9000 w.

*12096. Plumbing. John Honeyman (A L-April 7.) 5500 w.

12154. Plumbers Should Influence Sanitary Legislation. W. A. Kelly (D E-April 15.) 1000 w.

12155. Drain and Soil Pipe Ventilation. H. R. Kenwood (D E-April 15.) 3000 w.

12156. Sanitary Drainage and Ventilation. Charles Phelps (D E-April 15.) 1200 w.

*12183. Sanitary Science and the Coming Cholera. C. R. Hammerton (Ch-May.) 2500 w.

12228. Determining Grade of House Drain and Sewer (Met W-April 22.) 500 w.

†12247. The Drainage of Dacca. Editorial (I E-March 18.) 700 w.

†12322. Sanitation in Burma (I E-March 25.) 1200 w.

12342. The Ventilation and Heating of Schools. F. P. Smith (A Ar-April 22.) 2000 w.

*12352. Sanitary Administration of New York City. Cyrus Edson (A H-May.) 3000 w.

*12353. Relation of Sanitation to Municipal Government in Wisconsin. U. O. B. Wingate (A H-May.) 3000 w.

†12368. Municipal Sanitation: Defects in American Cities. J. S. Billings (F-May.) 2600 w.

12390. Use of Marine Salt for the Removal of Snow--Electrolytic Processes of Disinfection (Sc A S-April 29.) 900 w.

12463. How to Design a Sewerage System. Abstract of Lecture by Rudolph Hering (E R-April 29) 2600 w.

*12513. The Sewerage System of Memphis. George E. Waring, Jr. (P-May.) 3500 w.

*12584. The Sanitation of Country Mansions. Edward Tidman (N W-April.) 1200 w.

12663. Outlet Sewers in New York. Ill. (E R-May 6.) 800 w.

Serials.

8127. Ventilation and Heating. Ill. J. S. Billings (E R-Began Nov. 19—7 parts to date—15 cts. each).

10425. A Healthy Home. F. Vacher (S R-Began Feb. 1—6 parts to date—30 cts. each).

10942. New York Plumbing Regulations. A. H. Napier (E R-Began March 4—4 parts to date—15 cts each).

11166. Mr. Doig's Report on the Shone System at Rangoon (I E-Began Feb. 4—3 parts to date—45 cts. each).

11376. Plumbing in the New Netherlands' Hotel (E R-Began March 18—2 parts to date—15 cts. each).

11687. The Moral, Mental, and Physical Necessities of Ventilation. P. C. Remondino (N P R-Began April--Ended May—2 parts—30 cts. each).

11870. Heating and Ventilating School Houses by the Blower System. Walter B. Snow (Met W-Began April 8--2 parts to date—15 cts. each).

12248. Dacca Municipality. Ill. Report of the Drainage Engineer. J. D. M. Beglar (I E-Began March 18—Ended March 25—2 parts—45 cts. each).

12628. Heating and Ventilation of Residences. James R. Willett (I A-Began April—1 part to date—45 cts).

STEAM ENGINEERING.

*11872. Some Experiments on the Transmission of Heat Through Tube Plates. Ill. A. J. Durston (Eng L-March 31.) 5000 w.

11875. Boiler Capacity. W. H. Wakeman (M G-April 8.) 1000 w.

*11879. Observations on the Working of an Evaporative Condenser. Ill. Michael Longridge (I L-March 31) 2000 w.

*11911. Economy of a Non-Condensing Compound Engine (E R L–March 31.) 1100 w.

*11933. Engine Fuel: An Experiment. Walter J. May (C G–March 30.) 1000 w.

*11969. McLaren's Smoke Burner. Editorial (Inv–April 1.) 600 w.

11973. Boiler Feed Pumps (S E–April 1.) 2000 w.

*11977. Breakdown of Refrigerating Machinery. Manx (E G–April.) 2700 w.

*11980. The Steam Engine. Review of work by D. K. Clark (A L–March 31.) 2000 w.

12004. The Steam Man. Ill. (Sc A–April 15.) 600 w.

12045. Distribution of Heat and Boiler Settings. Paris, Texas (B J C–April 15.) 1800 w.

12046. About Open Heaters, Lower Manholes, and Curved Bridge Walls (B J C–April 15.) 900 w.

12055. High Steam Pressure (M G–April 15.) 700 w.

†12068. Discussion of paper by Charles E. Emery on "The Cost of Steam Power Produced with Engines of Different Types under Practical Conditions" (T A I E E–April.) 7500 w.

12092. Oil in the Boilers, Its Effect and Means of Remedy (E R–April 15.) 900 w.

*12100. The Darby Steam-Digger (I–April 7.) 1000 w.

*12104. Evaporative or Air Condensers for Steam Engines. Editorial (El–April 7.) 1100 w.

*12117. On the Use of Superheated Steam in Steam Engines. Bryan Donkin, Jr. (E–April 7.) 2000 w.

*12118. Harmonic Valve Diagram. Ill. W. E. Dalby (E–April 7.) 2700 w.

*12144. Slide-rule Illustrations (M W–April 7.) 1000 w.

12169. Latent Heat. A. D. Bartlett (A M M–April.) 700 w.

12192. Oil Engines for Small Powers (M N –April 15.) 700 w.

*12296. Steam Engine Trials. P. W. Willans (El–April 14.) 750 w.

*12298. The Coating of Cylinder Walls. A Bandsept (El–April 14.) 800 w.

*12346. The Design of Corliss Valve Gearing. Ill. A. H. Eldredge (S J E–April.) 1200 w.

12384. Behavior of Liquids at High Temperatures. J. Torrey (A M–April 27.) 2000 w.

12395. Basis of Duty Rating of Steam Motors (Ir Age–April 27.) 1750 w.

12412. Superheated Steam. Its Value in a Steam Engine Considered (B J C–April 29.) 800 w.

*12442. Scale in Steam Boilers (M W–April 21.) 1500 w.

*12454. Piston Rod Packings. B. W. Goodsell (N C B–May.) 900 w.

12462. Boiler Trials. W. H. Wakeman (M G–April 29.) 900 w.

*12471. Practical Notes on the Steam Jacket. Ill. W. Fletcher (P Eng–April 21) 2200 w.

12481. Exhaust Steam Induction Condensers. Ill. E. T. Ackerman (S E–April 22.) 2200 w.

12545. Losses in Transmission of Heat. R. C. Carpenter (Ir Age–May 4.) 2000 w.

†12577. Duty Trial of a Pumping Engine, Built by the George F. Blake Manufacturing Company. F. W. Dean (J F I–May.) 3800 w.

12592. Proper Area of Supply Pipes for Engines (P S–May.) 1600 w.

12612. The Duty of Pumping Engines (B J C–May 6.) 1600 w.

12680. The Progress of Steam Navigation. W. N. Brown (M N–May 1.) 1000 w.

Serials.

11102. Progress in Steam Engineering. Robert H. Thurston (E Mag–Began May—2 parts to date—30 cts each).

11138. Notes on the Steam Injector. Ill. Strickland L. Kneass (E M–Began March—2 parts to date—30 cts. each).

11180. The Expansion of Water by Heat. G. W. Buckwell (S L–Began March—Ended April—2 parts—30 cts. each).

11720. Steam Boilers (T–Began April 1—3 parts to date—15 cts each).

12377. Steam Shovels and Steam Shovel Work. Ill. E. N. Herrmann (E N–Began April 27—2 parts to date—15 cts. each).

TELEPHONY AND TELEGRAPHY.

11878. Progress in Fire Alarm Telegraphy. J. W. Stover (F W–April 8.) 3000 w.

*11909. The Telephone in Vienna. J. Hopkinson (E R L–March 31.) 1200 w.

†11952. Imperial Telegraph System — Cabling to India and Australia. J. Henniker Heaton (C R–April.) 4800 w.

*11967. Telephony in England. Editorial (E L–March 31.) 1300 w.

11986. A Novel Telephone Line Construction (E R N Y–April 15.) 350 w.

*12273. State Telephone to Ireland (E E L–April 14.) 600 w.

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*11924. The American Inventor. Editorial (E–March 31.) 3100 w.

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12234. Aerial Navigation. Editorial (E R–April 22.) 1200 w.

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12246. The Ethics of Engineering. John W. Ellis, William E. M'Clintock, and Albert F. Noyes (R G–April 21.) 2200 w.

*12253. New St. Louis. Ill. James Cox (L Mag–May.) 5500 w.

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†12324. The Kutubdia Lighthouse. Ill. J. H. Toogood (I E–March 25.) 2000 w.

*12345. Ethics for Engineers (S J E–April.) 5000 w.

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12375. "Maximite," a New Explosive (E N–April 27.) 600 w.

12386. Air Hoists. Frank Richards (A M–April 27.) 12000 w.

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12400. A Water Tower in Armour's. Ill. T. R. Tinsley (F W–April 29.) 400 w.

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*12489. Heat and Combustion. Angus Sinclair (L E–May.) 1500 w.

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†12503. The Hawaiian Situation. Theophilus Harris Davies (N A R–May.) 2000 w.

*12605. County Councils and Technical Education. Editorial (E–April 28.) 2500 w.

*12636. Some Problems of Municipal Engineering. C. D. Marx (I S F–May.) 6000 w.

12660. Overworked Foremen. Harry S. Williams (A S–May 6.) 1500 w.

12682. Social and Industrial Conditions of Arkansas. W. M. Finback (S S–May.) 1500 w.

Serials.

9401. World's Columbian Exposition. Ill. (E N–Began Jan. 5—9 parts to date—15 cts. each).

9745. American Industries and British Commerce (E–Began Jan. 6—13 parts to date—30 cts. each).

10535. Notes from the Engineering Schools (E N–Began Feb. 16—6 parts to date—15 cts. each).

11346. Historical Notes upon Early American Engineers and Their Work. Hale G. Robinson (Eng–Began March 18—4 parts to date—15 cts. each).

11678. Hot-Air Heating. Ill. (Met W–Began April 1—Ended April 8—2 parts—15 cts. each).

12382. The Ideal Engineering School (E N–Began April 27—2 parts to date—15 cts. each).

12477. Argentine (Eng L–Began April 1—2 1 part to date—30 cts).

12540. Early Engineering Reminiscences. George Escol Sellers (A M–Began May 4—1 part to date—15 cts).

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NEW BOOKS OF THE MONTH.

[For the convenience of readers any American books will be supplied at publishers' prices by The Engineering Magazine Co. Foreign books, 25 per cent. extra.]

Alexander, P.=Treatise on Thermodynamics. New York: Longmans, Green & Co. [8vo, cloth, 215 p., $1.50.]

Barr, W. M.=Pumping Machinery. A practical hand-book relating to the construction and management of steam power pumping machines. Philadelphia: Lippincott. [8vo, cloth, 447 p., $5.]

Benjamin, Park.=The Voltaic Cell. New York: Wiley. [8vo, cloth, 466 p., $5.]

Billings, J. S.=Ventilation and Heating. New York: The Engineering Record. [8vo, cloth, 500 p., $6.]

Bodley, C. E.=Pocket Reference Book for Tinsmiths and Sheet Metal Workers. Chicago: American Artisan Press. [63 p., paper.]

Brainard, F. R.=Knots, Splices, Hitches, Bends, and Lashings. New York: Practical Publishing Co. [16mo, 76 p., cloth, $1.]

Buckley, Robert Burton.=Irrigation Works in India and Egypt. A reference book with 100 folding plates and maps. New York: Spon & Chamberlain. [8vo, cloth, 340 p., $25.]

Catalogue of Berlin Iron Bridge Company. Complete and clear illustrations of the buildings, bridges, and general iron work of the company. Of special interest to manufacturers and engineers. East Berlin, Conn.: The Berlin Iron Bridge Co. [317 p., paper, Free on application.]

Catalogue of Niagara Stamping and Tool Company. Illustrations of Tools and Machines for Working Sheet Metal. Buffalo: Niagara Stamping and Tool Co. [104 p., Free on application.]

Chapman Valve Manufacturing Company.= Catalogue of Gate Valves and Fire Hydrants, with an Engineering Appendix. A book of great value to engineers, machinists, and all having to do with the construction or maintenance of work of all kinds. It also contains valuable articles on steam, electricity, and refrigeration. Hartford: Plimpton Press. [8vo, cloth, 146 p. Free to patrons on application.]

Cronkhite, Adelbert.=Gunnery for Non-commissioned Officers. New York: Wiley. [18mo, morocco, 450 p., $2.]

Garnsey, G. O.=The American Glossary of Architectural Terms. Being a concise and comprehensive compilation of all terms used in the practice of architecture and the building arts, with selected and original drawings. Chicago: Koelling & Klappenbach. [4to, cloth, $2.]

Goodhue, W. F.=Municipal Improvements. New York: Wiley. [12mo, cloth, 137 p., $1.50.]

Gotch, J. Alfred, and Brown, W. Talbot.= Architecture of the Renaissance in England. Illustrated by a series of views and details from buildings erected between the years 1560–1630, with historical and critical text. Boston: Ticknor. [Folio, 6 parts, paper, $8 per part.]

Goubert Manufacturing Co. (The).=Dry Steam the Foundation of Economy, with Description of The Stratton Separator. An illustrated catalogue with testimonials. New York: [8vo, paper, 36 p. Free on application.]

Grimshaw, Robert.=Engine-room Chat. New York: Practical Publishing Co. [12mo, cloth, 152 p., $1.]

Grimshaw, Robert.=Fifty Years Hence; or What May Be in 1943. A prophecy supposed to be based on scientific deductions by an improved graphical method. New York: Practical Publishing Co. [16mo, cloth, 92 p., $1.]

Haupt, Herman.=Street-Railway Motors. With descriptions and cost of plants and operation of the various systems in use or proposed for motor-power on street-railways. Philadelphia: H. Carey Baird & Co. [12mo, cloth, 213 p., $1.75.]

Hicks, I. P.=Hicks' Builders' Guide; Comprising an easy practical system of estimating material and labor for carpenters, contractors, and builders: a guide to those engaged in the various branches of the building trades. New York: Williams. [12mo, cloth, 162 p., $1.]

Hill, Robert Thomas =On the Occurrence of Artesian and Other Underground Waters in Texas, Eastern New Mexico, and Indian Territory, West of the Ninety-Seventh Meridian. Washington: Government Printing Office. [8vo, paper, 166 p., with Maps, $1.50.]

Hofman, H. O.=The Metallurgy of Lead and the Desilverization of Base Bullion. New York: The Scientific Pub. Co. [8vo, cloth, 415 p., $6.]

Hopkins, W. J.=Telephone Lines and Their Properties. New York: Longmans, Green & Co. [12mo, cloth, 272 p., $1.50.]

Houston, Edwin J.=Electrical Measurements and Other Advanced Primers of Electricity. New York: W. J. Johnston Co. [8vo, cloth, 429 p., $2.]

Jarchow, H. N.=Forest Planting. A treatise on the care of timber lands and the restoration of denuded wood-lands on plains and mountains. New York: Orange Judd Co. [12mo, cloth, 250 p., $1.50.]

Kapp, Gisbert.=Alternating Currents of Electricity. Their generation, measurement, distribution, and application. New York: W. J. Johnston Co. [8vo, cloth, 166 p., $1.]

Keenan, W. J. and Riley, J.=The Transmitted Word. Boston: Dorchester Press Co. [12mo, cloth, 116 p., 75 cts.]

Leon, Nestor Ponce de.=Diccionario Technológico, Inglés-Español y Español-Inglés. De los terminos y frases usados en las ciencias aplicadas, artes, industriales, bellas artes, mécanica, maquinaria, minas, metalurgia, agricultura, comercio, navegacion, manufacturas, arquitectura, ingenieria, civil y militar, marina, arte militar, ferro-carriles, telegrafos, etc. New York: N. Ponce de Leon. [8vo, half leather, 873 p., $8.50.]

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